New Series.] JANUARY, 1898. Vol. V. Part I.

BULLETIN

OF THE

BOTANICAL DEPARTMENT, JAMAICA.

EDITED BY

WILLIAM FAWCETT, B.Sc., F.L.S.

Director of Public Gardens and Plantations.

CONTENTS:

PRICE Threepence.

A Copy will be supplied free to any Resident in Jamaica, who will send Name and Address to the Director of Public Gardens and Plantations, Kingston P.O.

KINGSTON, JAMAICA:
GOVERNMENT PRINTING OFFICE, 79 DUKE STREET

1898

JAMAICA.

BULLETIN

OF THE

BOTANICAL DEPARTMENT.

New Series.] JANUARY, 1898. Vol. V. Part 1.

THE PUBLIC GARDENS AND PLANTATIONS OF JAMAICA.[1]

By William Fawcett.

INTRODUCTION.

Jamaica is about ninety miles south of Cuba. Its most western point is nearly directly south of Toronto, as it lies between 78° 20′ 50″ and 76° 11′ W. long. It is situated between 18° 32′ and 17° 43′ N. lat., so that it is only one to two degrees nearer the equator than the City of Mexico (19° 25′), and a little farther from the equator than Belize. It is a very small island, being only 144 miles long and 49 miles wide in its broadest part; its area amounts only to 4,207 square miles, of which very little is flat, and a great deal is not suitable for cultivation.

The aboriginal name of Jamaica was Xaymaca, denoting "a land covered with wood, and watered by shaded rivulets." The character expressed by the name is what one might expect to find in an island with lofty mountains, its shores bathed by the Gulf stream, and lying in the path of the trade winds. The general trend of the mountain ranges being at an angle to the direction of the prevailing winds, there is considerable precipitation nearly all the year round in some parts, while in other districts a small amount of rain falls during a few days only in two months of the year.

The general features of the landscape and of the flora which clothes it have been developed by the position of the island, and its geological history. The lowest strata containing fossils are the Hippurite limestone of the Cretaceous series. Below this there is a series of metamorphosed shale, sandstone and conglomerate, with dikes of intrusive diorite, syenite and granite. Above the Hippurite limestone are beds

1 Prepared for the Botanical Society of America, Toronto meeting, 1897, with special reference to the proposal to found a tropical botanical laboratory in Jamaica. Reprinted from the "Botanical Gazette," Nov., 1897.

of black shale, 1000 feet in thickness, overlaid by a trappean series, all of which are placed by Sawkins in the Eocene age. Then follow the yellow limestone of Miocene times, white limestone of very recent age, and marl, coast lime, and alluvium of post Tertiary times.

The differences in elevation from sea level to the 7423 feet of the Peak, the various exposures to sunlight, the abundance or the want of rain and dew, the geological formations, all have their influences on plant life, and make the conditions of existence of the most diversified character, and the cultivation of economic plants from all parts of the world an easier task than in most other places.

HISTORY OF THE GARDENS.

The first botanic garden in Jamaica was formed about 150 years ago by a private individual, Mr. Hinton East, on his property near the present village of Gordon Town, nine miles from Kingston. After it had been in existence for some years, in 1774 Sir Basil Keith became governor, and determined on the formation of two government botanic gardens, one a "European garden," and the other a "Tropical garden." In December of the same year a committee of the legislature recommended that £700 be appropriated for the purchase of a piece of land proper for a botanic garden, and that £300 sterling be provided for the annual salary of a botanist.

In 1775 a property named Enfield, adjoining Mr. East's garden, was purchased and Dr. Thomas Clarke came out "at the particular instance and request" of Sir Basil Keith, as island botanist, and to take charge of the gardens. Dr. Clarke introduced in 1775 the china tea plant, camphor, litchi, *Cycas circinalis* (the "sago palm"), and *Desmodium gyrans*; in 1778 *Blighia sapida* (Akee); and in 1779 the clove tree. Enfield being a "steep hillside," proved unsuitable, and in 1778 a law was passed to purchase land for a botanic garden at or near Bath. The botanic garden at Bath was founded in 1779 and placed under the care of Dr. Thomas Clarke.

In June 1782 Captain Marshall, of H. M. S. Flora, one of Lord Rodney's squadron, captured a French ship bound from Mauritius for Haiti, carrying a number of plants of economic value. The ship was sent as a prize to Jamaica, and Captain Marshall "with Lord Rodney's approbation" deposited the whole collection in Mr. East's garden. Many plants were new introductions, and amongst these were the mango, cinnamon, and jack fruit.

On Mr. East's death in 1790, the Liguanea garden was offered by his nephew to the assembly as a public garden at their own price. It was purchased under the authority of an act of the Assembly, the preamble stating that the garden in Bath was insufficient in extent, and was besides liable to be carried away by the river which had destroyed two-thirds of the town.

In 1793 Captain Bligh in H. M. S. Providence brought several hundred plants of the breadfruit and other valuable plants from Otaheite for the West Indies. These were distributed to the gardens at Liguanea and Bath, and to other centres, and committees were ap-

pointed to make arrangements for their reception, the care of them, and their distribution. One of the gardeners, James Wiles, who had circumnavigated the globe with Captain Bligh, was appointed to the care of the Liguanea garden, and writing to Sir J. Banks, in 1793, he says :

All the trees under my charge are thriving with the greatest luxuriance. Some of the breadfruit are upwards of eleven feet high, and my success in cultivating them has exceeded my most sanguine expectations. The cinnamon tree is become very common, and mangoes are in such plenty as to be planted in the negro grounds.

In 1782 Dr. Thomas Dancer was elected physician of the Bath of St. Thomas the Apostle; in 1788 he was appointed by the legislature superintendent of the Bath garden; and in 1797 island botanist. The duties of the island botanist were defined as follows;

To collect, class, and describe the native plants of the island; to use his endeavours to find out their medicinal virtues; to discover if they possess any qualities useful to the arts, and annually to furnish the House with a correct list of such plants as are in the botanic gardens, together with such information as he may have acquired relative to their uses and virtues.

In 1799 Dr. Dancer went to practice in Kingston. He made the medicinal plants of the island a special study, and published in 1801 "The medical assistant, or Jamaica practice of physic." He died in 1811.

The colony had now to undergo a period of difficulty and distress, as the slave trade was abolished in 1807 without compensation to the planters, and the wars with France and the United States caused great depression. Accordingly in 1810 the Liguanea garden was sold, and that at Bath was never afterwards adequately supported.

In 1825 Dr. Jas. MacFadyen was appointed island botanist. In 1837 appeared the first volume of his *Flora of Jamaica*; in 1850 part of the second volume was printed, and this was all that was published. He did not retain his appointment long; and in 1828 Thomas Higson was appointed island botanist and curator of the botanic garden at Bath. He presented to the garden a collection of living plants collected by himself in South America.

In 1829 the garden at Bath, of one and three-fourths acres, was increased by three acres to the west. Higson left Bath in 1832; and in 1846 Nathaniel Wilson was appointed island botanist with the care of Bath garden. Wilson had been in the gardens at Kew and at Kensington for several years, and was a most capable man. He kept up a correspondence with Sir W. J. Hooker, director of Kew gardens, and introduced a very large number of plants from Kew and other parts of the world, trusting to be repaid his expenditure by the liberality of the assembly. *Bœhmeria nivea* was imported by him, and he formed a very extensive collection of fibre plants. He also received from Kew in 1846 and 1847 the mangosteen, litchi, durian, and *Musa Cavendishii.* In 1849-1850 he reports the arrival of Poinciana, Spathodea, *Bougainvillea spectabilis*, *Cæsalpinia Sappan*, Amherstia and Assam tea.

In 1851 there was some intention of moving the site of the garden elsewhere, and Wilson, referring to Bath, says in his report for that year:

I would most unhesitatingly say that a more congenial climate for the growth and propagation of plants is not to be met with in the island. The humidity of the atmosphere is proverbial and suitable to a peculiar degree for plants in general.

In 1856 the Sulphur river inundated the garden for the fifth time since 1848 and destroyed half an acre. These floods and the impossi bilily of extending the garden for the growth of additional plants were constant difficulties with Wilson, and in 1858 he says:

The attention of the executive has of late been pointedly directed towards it [the garden] with a view not only to place the establishment on a scale of permanent efficiency, but in a more central locality, accessible from all parts of the island . . . . The want of a more central and extensive depot has long been felt, particularly at the west end and north side of the island, where distance renders it impracticable to convey plants safely, and where industrial institutions and experimental gardens are springing up.

In 1860 the legislature appropriated money for the purchase of Castleton, and Wilson was entrusted with the formation of a garden there, on the understanding, however, that the garden at Bath was to be maintained for supply of seeds to Castleton, and plants for general distribution. In his report for 1861, he states that Sir W. J. Hooker had sent out the previous year seeds of *Cinchona succirubra. C. nitida,* and *C. micrantha,* and that several hundred plants were ready for planting out. At this time the market price for succirubra bark was 6s. per lb. In 1862-63 an assistant to Mr. Wilson was appointed, Mr. Robert Thomson, and the formation of the garden at Castleton was commenced.

Experiments were made in planting out cinchona in different parts of the Blue mountains, and at length in 1868, during the governorship of Sir John Peter Grant, the cinchona plantations were started under Mr. Thomson as "superintendent of botanic gardens" in succession to Mr. Wilson.

Six hundred acres of virgin forest land were assigned for planting cinchona by Sir J. P. Grant on the southern slopes of the Blue mountains, ranging from 4000 to 6000 feet above sea level, and a commencement of work was made in the same year (1868) by planting out forty acres with five species of cinchona. Now also a first beginning was about to be made to realize the conception of Sir Basil Keith of nearly a hundred years before to have a "European garden" in a temperate climate. A small plantation was made in 1869 of Assam tea, and afterwards of a hybrid between the Assam and China. *Eucalyptus globulus* from Australia, *Cupressus macrocarpa* and *Pinus insignis* from California, and *Pinus excelsa* from the Himalayas are among the forest trees planted out and flourishing in later years. In 1869, 40,000 plants of cinchona were offered for sale at rates of £5 to £7 per 1,000.

At Castleton, up to 1869, there had been no general importation of plants, because of doubts about maintaining the garden on account of its distance from Kingston. In the Blue Book for 1871 Sir J. P. Grant says:

The famous Jamaica botanic garden of ancient times, which was not only of the highest intrinsic value, but also was admirably situated, was sold, I believe, for a trifle, and was broken up a long time ago, in some spasmodic fit of false economy. More lately a botanic garden was established at Bath. The site was unfortunately selected, being a long day's journey from the capital. But the purchase, in 1859, of Castleton, and its formation in 1863 into a new botanic garden in substitution for the garden at Bath, which was finally abandoned in 1866, is said to have been determined upon because of serious damage caused and threatened by a water course. The selection of Castleton as the site of the new garden was also unfortunate, as it is a distance of nineteen miles from Kingston; and it is important to interest the public as much as possible in such an institution as a botanic garden. But the selection having been made, and a large number of plants having been established there, whilst the position, except in respect of its distance from the capital, is unexceptionable, it would have been unwise once more to have thrown away all that our predecessors had done for us by removal to a fourth position. It was determined therefore to treat the Castleton garden as a fixture; and as it is not too far from Kingston for a holiday excursion, to go to some little expense in its gradual embellishment, in the hope of attracting visitors to what I believe will certainly become one of the most interesting spots in the West Indies.

As soon as this determination had been arrived at in 1869, Dr. (now Sir) J. D. Hooker sent out from Kew great numbers of new and valuable plants, 400 different species and varieties, among which were mangosteen, Brazil nut, bhel, *Monstera deliciosa*, carob bean, cocoa, Tonquin bean, teak, New Zealand flax, and thirty-two species of palms. In the same year two cases of grafted mangoes arrived from India *via* Kew; Mr. Thomson states that "to His Excellency the Governor, from his personal knowledge of Indian mangoes, we are obliged for their introduction." Even at this early period of its existence the nutmeg trees began to bear fruit, and the clove trees were six feet high.

In the same Blue Book quoted above, Sir J. P. Grant reports that a gardener had been obtained from Kew to reside at Castleton, as Mr. Thomson had taken up his residence at the cinchona plantations thirty-four miles off, in the Blue mountains. He took charge at Castleton in December, 1870.

Upwards of 200 species of plants new to the island were introduced during the year. Among these perhaps the most interesting were two plants of Ipecacuanha, two true mangosteens, and five choice varieties of pine apples; also four noted Bombay grafted mangoes, imported two years ago, are very flourishing, some of them being already five feet high. My belief is that there is nothing to prevent Jamaica becoming, for the quality, variety, and commercial value of its fruits, the most noted spot in the world, when gardening shall be understood, and the value of the art shall be duly recognized here.

In 1870, four varieties of orange were imported, viz., navel, St.

Michaels, tangerine and mandarin. In after years thousands of grafted plants of this St. Michaels, and seedlings also of the tangerine and mandarin were distributed all over the island. A large tank was made for the cultivation of the *Victoria regia,* which has been growing there ever since.

This was a period of great importance in the history of the development of the public gardens. In 1868 the government undertook to plant out in coco-nuts the narrow sandy strip of land, known as the Palisades, with Port Royal at one end, forming a natural breakwater for the magnificent harbour of Kingston. The first clearing and planting was done early in 1869, and by 1879 nearly 20,000 coco-nut palms had been planted out, and 700 of them were bearing fruit. In 1870 £1,800 was voted for the establishment of a garden in the Parade square of Kingston, and in 1871 £2,267 were voted for continuation of the work. This sterile waste in the centre of the city about seven acres in extent, Mr. Thomson reports in 1871, was enclosed with a handsome iron railing. In 1871 the governor ordered that:

In an appropriate quarter of the garden at Castleton space should be reserved for every species of cane procurable, so as, if possible, to afford specimens of every true, distinct, and permanent variety known. The botanical garden of Jamaica should not be behind any garden in the world in regard to specimens of this particular sort of plant.

The governor applied to Mauritius and Martinique for specimens of all varieties of cane grown there. Over sixty varieties of sugar cane were received in 1872 and 1873 from Mauritius, and the salangore from Martinique.

In Sir J. P. Grant's report in the Blue Book for 1871, published in the *Gazette,* October 1872. he says:

The Bombay grafted mangoes, planted three years ago, are in a thriving condition, and from eight to nine feet high. I do not doubt that the finest varieties of this almost unequalled fruit will thrive here quite as well as at Bombay. The plant has naturalised itself here in the course of only ninety years, and now spreads itself self-sown over large tracts in all parts of the island. As the propagation has been exclusively from seed, it is surprising to find amongst these wild trees so many bearing fruit at all eatable, which I think could not be the case were not the climate and soil very propitious for this plant. The quantity of fruit produced is remarkable, and it is greedily devoured by horses, cattle, and swine. With vessels running in six days to New York, the commercial value of an orchard of fine Bombay mangoes near Kingston would surely be very great.

Mr. Thomson in his report for 1873, referring to these mango trees, points out that:

Although the climate of Castleton is extremely favourable for the growth of these plants, the reverse is the case so far as the production of fruit is concerned. As soon as possible, however, a small plantation of these varieties will be established at the proposed garden at Hope, which, wtth its far drier climate, is probably as good a locality as any in the West Indies for the production of this fruit.

In 1873, the report of the gardens states:

Arrangements have been made to commence operations at Hope, with the view of establishing a pleasure garden and a small sugar cane farm for experimenting upon new varieties of canes. The climate of the Castleton garden is too humid for numerous species of plants, which will find a congenial home in the drier climate of the Liguanea. . . . . The establishment of this garden, simultaneously with that on the Parade, coupled with the greatly increased command of water in the course of being brought to Kingston, must undoubtedly constitute a new era in the history of horticulture in Jamaica.

It was found advisable to secure the services of a skilled European gardener at Cinchona. Accordingly Mr. Nock arrived here in April, 1874, from Kew gardens. He devoted attention to the cultivation of European vegetables, which he hoped to show may be successfully grown in great abundance and variety under our conditions of climate. Mr. Thomson says in 1875, that:

Mr. Nock has been very successful in producing an assortment of vegetables such as are not grown elsewhere in the island. It is to be hoped that the peasantry will initiate the cultivation of similar vegetables, as these experiments show that at this height (5000 feet above the sea) almost all European vegetables can be grown with advantage.

These hopes have been fulfilled, for the peasantry now grow all kin d of " English" vegetables in the Hill gardens district.

In 1876 a plantation of Liberian coffee was established at Castleton.

W ith reference to the "Hope experimental grounds," Mr. Thomson wrote:

It is about three years since the government obtained possession of upwards of 200 acres of Hope land, contiguous to, and for the most part under the level of the Hope reservoirs. The acquisition of this land afforded an excellent opportunity for experimenting upon the numerous new varieties of canes that had just been imported from the Mauritius botanic garden. While this matter was under consideration, it was also proposed that the beautifully situated land in question should be utilised in a variety of ways. Among other schemes it was proposed that, in consideration of the accessibility of this locality to Kingston, a pleasure garden should be formed for the inhabitants of that city.

But the want of water prevented anything more being done than planting out a few canes, and forming a small nursery.

The collection of new suger canes, embracing some sixty varieties of new canes, imported a few years ago from the Mauritius botanic garden, was in the first place establiseed at Castleton garden. As the necessary scope and appliances at Castleton for the experimental cultivation of these canes on a sufficiently large scale were not obtainable, advantage was taken of the government land at Hope to carry out the necessary experiments. Accordingly in 1874 the first batch of canes, consisting of eighteen varieties. was transferred to Hope and planted to the extent of nearly an acre each. In 1875 the remaining varieties at Castleton, numbering upwards of forty, were removed to Hope, and there planted in small plots in order to ensure

a command of cuttings for subsequent propagation, the area occupied by these being about five acres.

But water failed often and there was disappointment. Some fifty plants of teak were set out at Hope in 1874, and 500 plants more in 1875. About ten acres were thus planted with teak.

Mr. Thomson retired on pension in 1878, and in December, 1879, the gardens and plantations were constituted a department under Mr. Daniel Morris as director. The management of the gardens and grounds attached to King's House, the residence of the Governor, was now placed under the department. Dr. Morris, in his report for 1885, refers to the future development of Hope nurseries.

The only drawback to this locality as a site of a botanic garden is the smallness and precarious nature of the water supply. . . . . Although sufficient for the nurseries this water supply is wholly inadequate to maintain a large area, such as a botanic garden must necessarily be, under perpetual cultivation, unless a system of reservoirs and tanks were introduced for the storage of water.

The Hope plantation might, however, be greatly extended in the direction of growing and distribuing economic plants, and in this respect the establishment would prove of great service to the island. As circumstances permit, this work will be transferred as much as possible from Castleton, leaving the latter to supply only the districts in communication with the main trunk road and the north side.

The lands adjoining the Hope nurseries, about 100 acres in extent, might be cleared and laid out as a public park, with grass lawns and shade trees, and afford a convenient and healthful resort for the inhabitants of Kingston and Half Way Tree. At present, persons driving along any of the hot, dusty, and dreary looking roads leading out of Kingston have no place where they could get out of their carriages and enjoy a walk under shade. With the exception of the Parade garden, Kingston, which is largely frequented by the poorer classes of people residing in the immediate vicinity, there is no place of the nature of a park in the island. In the neighbourhood of every tropical city it is very necessary to have a public park provided with seats and ample shade trees where the people can for a time, at least, escape from the heat, and glare, and dust, and where they come into contact with some of the fresh invigorating influences of nature.

The cost of laying out a park at Hope in conjunction with the experimental cultivation of fruit trees and nurseries of economic plants would be about £4,000 to £5,000.

The governor, Sir Henry Norman, commenting upon this view of the future of Hope, wrote ;

As regards the Castleton and Hope nursery gardens, it will be seen that there is a tendency rather to increase the usefulness of the latter than the former, and considering the inconvenient situation of Castleton this seems right. Measures may be taken from time to time to improve the Hope gardens, but I am not prepared to recommend outlay from public funds for the construction of a park at the Hope. It is situated five miles from Kingston, which is too great a distance to allow of the poorer classes of the population enjoying the benefits of the proposed park.

The scheme proposed now to connect Kingston and Hope gardens by an electric tramway with cheap fares removes the objection that the poorer classes of Kingston would not be able to make use of it.

Dr. Morris left Jamaica in March 1886 to take up an appointment as assistant director of Kew gardens. Sir H. Norman then referred to a committee of the legislature the consideration of the condition of the department, and the provision to be made for its maintenance in the future. The committee submitted a report, which was adopted by the council in October 1886. In it the committee state that they

Fully recognize the importance to a purely agricultural colony of an organized department for the giving of reliable and authoritative information in matters of agriculture and cultivation and for the dissemination of such knowledge. The importance of this is specially enhanced at the present time when the depressed condition of our staple products in the markets of the world suggests not only the application of all means of science and invention to their more perfect and more economical production, but also the encouragement of the cultivation of those so-called minor products for which the soil and climate of this island are so fortunately suited. Courage may be taken from the experience of Ceylon, where the effects of the failure of its great staple of coffee have in a few years been largely diminished by attention to the cultivation of tea, cocoa, and other products, which has been materially benefited by the interest and fostering care of the botanical department of that island. The influence of a trained and scientific chief over such a department must be felt as well in the interchange and in the consequent continuous and careful thought of the information and experience of old and practical planters and cultivators, as in the education and training of the younger and inexperienced, and in the intelligent and profitable application of means and labour of both peasant and proprietor, to present and to new objects of cultivation.

The work of the gardens department, its chief aims and possibilities, have frequently been brought before the public of Jamaica in the present director's annual reports. Thus in 1892 occurs the following:

The two main divisions under which work in a colonial botanical department may be classed are: first, the supply of plants yielding products new to the agriculture of the colony, or of a better kind, or such as are not readily obtainable otherwise, involving experimental and nursery grounds in such situations as are suitable: second, the providing of information regarding the kind of soil, climate, etc., fitted for the plants, their proper cultivation and preparation for the markets. The second division is most economically and effectively carried on by means of printed matter combined with correspondence; but practical demonstration of methods in the gardens are advisable whenever they can be carried out. Both divisions imply considerable correspondence with persons in other countries as well as a complete herbarium and a good library.

During the past twelve and one-half years, from the time that Mr. Morris was first made director, to March 31, 1892, about 220,000 plants have been distributed from Castleton alone, besides seeds which would produce at least as many plants. This gives an average for a year of 17,600 plants and includes those sent to Hope for distribution from that centre.

Of those plants, about half the number were such as may be termed strictly "economic", such as cocoa, nutmeg, cloves, cinnamon, Liberian

coffee, vanilla, oranges, East Indian maugoes, cardamom, kola. The remainder were palms, roses, ferns, orchids, and miscellaneous trees and shrubs, among which are included timber trees.

I stated in my report for the year 1887-8 that although it was not the mission of a botanic garden to undertake the work of a horticultural establishment, and supply the public with ornamental plants, I thought it right to do as much as possible in that direction, so long as there was no probability of interfering with private enterprise.

But the danger of interfering with trade seems remote, and the demands on the part of the public are positive and increasing. There has been an annual demand for some 8,000 or 10,000 ornamental plants, and even more than the department can supply with its present means. The question may sometimes arise, is the government right in fostering this demand; is it a legitimate one; is some great end served by the necessary expenditure, and the attention to the numberless details that it implies?

It appears to me that the question only needs to be stated for all intelligent persons to answer in the affirmative. Bacon recognises a love for gardening as an index of a nation's advance in civilisation, and without doubt it is an important factor in rendering that advance more easy and more certain. He says, (Essay 46) " God almighty first planted a garden and indeed it is the purest of human pleasures. It is the greatest refreshment to the spirits of man, without which buildings and palaces are but gross handiworks; and a man shall ever see that where ages grow to civility and elegancy men come to build stately, sooner than to garden finely: as if gardening were the greater perfection".

The plants, cuttings, and seeds, both economical and ornamental from Castleton as well as from the other gardens, are distributed all over the island by means of the coastal steamer, the railway, and the post office.

The increase in the variety of cultural products, and the humanizing influence of ornamental plants are matters of appreciation in every part of the country from the mountain to the sea coast. Every person who obtains plants and grows them, from the sugar planter who makes trial of different varieties of cane, to the small settler who grows a nutmeg plant, is making experiments which are of direct benefit to himself and indirectly to his neighbours and to the district.

Parochial or other associations can do a great deal to help the work by meeting periodically to discuss all matters connected with agriculture, The sympathy felt between those engaged in kindred pursuits, the feeling of rivalry aroused to attain better results, the mutual aid obtained by interchanging ideas are all most valuable in the improvement of agriculture. He who undertakes the laborious task of starting such an association in his own district, though he may find few at first to join him, yet by perseverance with even only one or two sympathisers will eventually meet with his reward. Such an association and this department can render mutual assistance to each other in many ways with results that will be of general benefit to the whole island.*

The great importance of Castleton as a botanic garden over the other gardens may be estimated from the fact that there are some plants such as vanilla, which will only grow naturally there, and that there are others such as roses which can only there be successfnlly propagated. Castleton must therefore always be the great propagating centre.

* The local association work has been undertaken by the Jamaica Agricultural Society formed in 1895.

It is scarcely necessary to say anything in Jamaica about the importance generally of botanic gardens for the need for them has been continuously recognized there for more than one hundred years. The value of those existing in Jamaica. Trinidad and Demerara, is so evident that lately botanic gardens have been started in Antigua, Dominica, Montserrat, and St. Kitts Nevis, among the Leeward Islands; in Grenada, St. Lucia, and St. Vincent among the Windward Islands: and still more recently in British Honduras.

The same movement is also going on in other parts of the world; for instance botanic gardens have lately been established in Lagos and the Gold Coast on the west coast of Africa.

Botanic gardens in the tropics do the work on the plant side of Agricultural deportments in temperate climates. They are in themselves experimental stations; and are much more efficient in introducing new cultural products, and in distributing plants and imparting useful information, than most agricultural departments.

The whole of the botanic gardens in the British empire are more or less in communication with one another, exchanging seeds, publications, etc., and all look up to the Royal gardens at Kew. as to their head for advice and assistance. Imperial federation is already in existence as regards the botanic gardens and their work. If any special variety of a plant or any new culture comes into notice information and plants are sought sometimes directly from the local gardens; sometimes through Kew as the botanic gardens' clearing house. The director of Kew gardens has at his disposal the services of experts in every branch of botanical inquiry, and is always most willing to aid colonial gardens in every way. Any intricate question that arises in chemistry, in diseases of plants, in insect pests, in the value of products, etc,, can be determined by reference to Kew. Colonial gardens are threfore not isolated, but are branches of an agricultural department as wide as the British Empire itself.

In 1896 the following paragraphs are found:

Although the means and the number of men at my disposal are infinitely small as compared with the resources at the command of the government of the United States, we try to follow at a very long distance the aims and the methods adopted by them. Dr. A. C. True, the director of the office of experiment stations in the United States, has lately given a lucid exposition of the objects and work of these stations, and an extract from his bulletin will very clearly illustrate what we should always be striving after here.

Then follow extracts showing what the objects of the stations are and details of their work. Chemical analysis and the study of live stock are outside the limits of our sphere at the gardens, but attention is paid to nearly all the other points detailed.

Dr. True continues:

The service which the stations have rendered in promoting the education of our farmers is incalculable. Even if the station bulletins recorded only facts well known to scientists and advanced agriculturists, the influence of such a far reaching system of popular education in agriculture must be very great. So vast a scheme of university extension has never been undertaken in any other line. The stations have also taught the farmer how to help himself.

The *Jamaica Bulletin* which was started in a small way in 1887, appearing at irregular intervals, has now increased to a publication of twenty-four pages appearing regularly once a month. It is sent free by post to all who ask for it, and the circulation is steadily increasing. The department, indeed takes in some respects a wider scope than the experiment stations of the United States, for not only are practical lectures given in various parts of the island, but an agricultural elementary school is managed under its auspices, and the boys are trained in practical work in the gardens

Parade Garden.

The Parade garden was formed for the recreation of the inhabitants of the City of Kingston, the principal port of the island and the seat of government. It is about seven acres in extent, with shady lawns, lily tanks, borders of ornamental plants, and numerous palms and tropical flowering trees. It is lighted in the evenings by electric light, and a military band performs once a week. Elevation, 60 feet; annual mean temperature, 79° F.; average rainfall, 34.73 inches.

King's House Garden.

The garden and grounds around King's house, the residence of the governor, amount in extent to 177 acres. The avenue from the entrance gate to the house is formed of the willow fig (*Ficus benjamina*), and the royal palm (*Oreodoxa regia*), with borders of ornamental shrubs and creepers, such as crotons, Hibiscus, Acalypha, Tabernæmontana, Mussaenda, Tinnea, Bambusa, Dracaena, Musa, Bignonia, Antigonon, Stephanotis. In the garden, adjoining the house, there are orchids, ferns, palms, climbers, and ornamental plants generally, with several lawns. and a tank for nymphæas and the *Victoria regia.* Elevation, 400 feet; annual mean temperature, 78.7° F.; average rainfall, 47.24 inches.

Hope Garden.

Hope garden is situated in the Liguanea plain between five and six miles from Kingston at the base of the hilly country through which the road passes for ten miles or so to the Blue mountains. The plain of Liguanea is one of the dry districts, the average annual rainfall at Hope being only 51.5 inches. Vegetation is affected not only by the want of rain, but also by the sea breezes, which in their passage across the plain become quite dry. The plain is characterized by the presence of Cactaceæ, such as various species of Cereus and Opuntia. The trees include *Prosopis juliflora* (cashaw or the mesquite of the mainland,) *Guiacum officinale* (lignum vitæ), *Parkinsonia aculeata* (Jerusalem thorn.) As we approach Hope, at the base of the hills the rainfall increases, from 35 inches in Kingston, and *Catalpa longissima* (the yoke wood tree), and *Pithecolobium Saman* (the guango) occur, while the Cactaceæ disappear.

The character of the flora is affected also by the soil, which is alluvial without any admixture of clay. Where limestone rock commences on

the hill called Long mountain the prevailing feature is the beautiful yellow flowered *Agave Morrisii.* The soil of the plain is very fertile when irrigation can be used, and the gardens in fact form part of the old Hope sugar estate.

From being at first a small nursery and an experimental ground for sugar cane, it has now developed into a large garden with six acres of lawns, three and one-half acres of ornamental borders, also ferneries and orchid houses; collections of roses, crotons and palms; plantations covering seven and one-half acres of sugar cane, Arabian and Liberian coffee, oranges, ginger, tobacco, ramie, and five or six acres of teak. It is hoped that in time it may be possible to make it a geographical botanic garden with different sections for India, Australia, China, etc. Two and one-half acres are given up to the nurseries which contain about 70,000 plants, such as cocoa, nutmeg, clove, orange, vanilla, cinnamon, Liberian coffee, rubber plants, etc. It is the distributing centre, and on an average 40,000 plants are sent out all over the island each year. The director has a residence, office, library, and herbarium in the garden. Elevation 700 feet; annual mean temperature 77.4° F.; average rainfall 52.83 inches.

HILL GARDENS.

The following account of the possibilities for usefulness of the Hill garden was written by me eighteen months ago: The ceremony, by His Excellency the Governor, of cutting the first sod of the new driving roads along the southern slopes of the Blue mountain range, inaugurated a new era of prosperity for a wide stretch of country from Newcastle to the Cuna-cuna pass. The only means of communication, until quite lately, in all this region from one district to another and to the sea-coast road, was by bridle paths, a terror to nervous riders and impossible for invalids. The road connecting the plain of Liguanea with Gordon Town is so short that it scarcely counts when there is now a commencement of the construction of roads which are to be 100 miles in length. The only cultivation in these mountains on a large scale has been of coffee, and this industry has been seriously hampered by the expense and difficulty of transport.

In 1868, Sir John Peter Grant with great foresight made the first attempt at another culture, one which could be carried on at higher elevations, namely cinchona. The experiment was a complete success, for the government established the fact that cinchona could be grown in the island, and realized a sum of about £17,000 by the sale of bark. But for the very reason that the whole reagon was without roads, planters hesitated so long about embarking in the new industry, that the golden opportunity was lost, the price of cinchona bark fell, and many persons lost money in the venture, whereas in Ceylon, with good roads and railways, fortunes had beeen made by all the pioneers.

Here in Jamaica, the loss to private individuals of large sums in cinchona planting, coinciding with the low prices for coffee and general depression in trade, led to the cry some ten years ago that the Hill garden instituted by Sir J. P. Grant had proved a failure, and should

be abandoned. Fortunately this desponding wail has not bnee generally supported in the island, nor acceded to by the government. Six or seven years ago, Mr. Thistleton-Dyer, the director of Kew gardens, gave it as his opinion that it was quite possible that the Hill garden might again become the chief botanic garden of the island, and this prophecy, unlikely though it might have seemed to most, seems now in a fair way to become fulfilled, and to justify the faith of the few. The garden ss situated about half way between Newcastle and Abbey Green, and the elevation of the government property ranges from about 3000 to 6300 feet, so that greatly varied experiments can be made in cultures requiring different altitudes.

The Hill garden, however, was not devoted solely to the cultivation of cinchona. Vegetables have been grown and instruction imparted so successfully, that all the settlers round for many miles grow such "English" vegetables as peas, cabbages, carrots, turnips, potatoes, artichokes, horse-raddish, cucumbers and beets. Tea has been grown of a quality declared by London brokers to be excellent, and an order has just been received from a planter for 1000 plants. Timber trees of various kinds have been planted out and tended for years, and a knowledge gained of the capabilities of different trees for use in these hills where nearty all the valuable timber has already been cut. The nurseries at present contain some thousand of seedling trees. Fodder plants have been under experiment as well as many different kinds of economic plants, which will be taken up by planters in the near future, such, for instance, as jalap, which sells at 1s. 6d. per lb., orris root at 75 to 80s. per cwt., China grass, a variety of ramie which can only be grown successfully in the hills, and realizes twice the price of the tropical ramie, and fruit trees of temperate climates, and of high elevation both in the new and old worlds.

As this region is the best in the island for coffee, it is raasonable to suppose that it is the best for oranges, since the soil requirements of both are much the same. Although no tests have been made in comparing the oranges of Manchester with those grown here, many who know both, declare in favor of those grown in the Port Royal mountains where splendid fruit is produced at as high an elevation as 4100 feet.

The government has very lately established an orange experimental garden and nursery as part of the Hill garden establishment at an elevation of about 3900 feet. A large number of budded and grafted trees have been imported from Florida, and also from Rivers in England, who supplied growers in Florida and California in the early days of their groves. These are permanent stock trees, from which buds will afterwards be taken for budding on Seville and lemon stocks. Several thousand seedlings of the above stocks are being grown, also of the Jamaica sweet orange, grape fruit, tangerine and shaddock.

Olives have been grown in the island for many years, but so far no fruit, nor even a flower, has been produced. It is probable that this may be accounted for by their having been planted at too low an elevation. Eighty plants of the variety frantojo, which yields an excellent oil, have just been presented for trial by Lord Malcolm, of Knock-

alva, and these, together with others from Florida, have been put out at various elevations ranging from 3500 feet to 5500 feet.

Grape plants from Persia have been imported from California. They grow on the table-lands of Persia, have a distinctive character of their own, and are very highly spoken of by travelers. They ripen early, and as they have a firm and tough skin they will probably prove serviceable for early shipping. The native grape of Jamaica, so abundant in these hills, though of no value as a fruit, may turn out to be of special worth for grafting the more tender European varieties.

These are a few of the cultures which may be taken up when roads are made. The prosperity of the Jamaica will advance by leaps and bounds with the increased production rendered possible by means of communication, and a temperate climate all the year round will be available for invalids, within a few hours' drive of Kingston. But these benefits will also attract settlers from England when it becomes known that we have a Florida and a California in an island under British rule, with all the advantages of those climates and none of the disadvantages. Elevation 3000 to 6300 feet; annual mean temperature at 4900 feet is 62.7° F., average rainfall, 105 inches.

CASTLETON GARDEN.

The drive from Kingston of nineteen miles, though a long one is full of interest. The start is made in the fresh cool air of dawn; the road leads through the plain of Liguanea with a view of the hills in the distance, bright with the ever-changing hues of early daylight. Then the assent becomes steeper, passing by settlers' groves of cocoa, coffee, and bananas, with a sprinkling of oranges, akees, sugar-cane, annatto, and yams. The road passes over the crest of an elevation of 1360 feet at Stony Hill; thence down into the valley of the Wag water, with broad alluvial stretches covered with tobacco, cultivated by Cubans; along the winding river fringed with clumps of graceful bamboo plumes, and its banks hidden by masses of creepers; past the rocks by the roadside covered with ferns, mosses, the scarlet "dazzle," and the blue Jamaican "forget-me-not," until Castleton is reached, where art shows nature at its best by world-wide selection and harmonious combination.

At the principal gate stands one of the most superbly beautiful of all trees, the *Amherstia nobilis*, which, when in flower in the spring is worth crossing the ocean to see. Further on we see *Norantea guianensis* climbing over a large tree, and brilliant with long spikes, not of flowers but of nectar-secreting bracts; *Mesua ferrea* attracting attention not so much by its large fragrant white flowers as by the red colour of the young drooping foliage; the mangosteen with its delicious fruits the travellers' palm of Madagascar; *Araucaria excelsa* from Norfolk island. The palmetum contains specimens of 180 species of palms with great variety of graceful forms. The water lily tank is wonderfully beautiful with its surroundings of palms, bamboos, and grassy slopes, and the placid surface of bright water on which float the symmetrical leaves of red, white and blue lilies, and the *Victoria regia* in the centre, queen of the rest. From the brightness of the still lily

pool we pass to the grateful shade of the ferneries with the quick stream dancing over the stones, and then on to the nutmeg tree, its yellow fruit splitting and displaying the "mace," a network of scarlet covering and half concealing the brown nut; the spicy clove and cinnamon trees; the climbing vanilla and black pepper; the coffee, cocoa, and kola trees; the peculiar flowers of the Couroupita and Napoleona.

There is a small hotel in the grounds of the garden, open during the winter months, and as the importance of the garden has increased, a post and telegraph office, and constabulary station have been lately erected. The railway station at Annotto bay is only nine or ten miles distant.

Elevation 580 feet; annual mean temperature 76.2° F.; average annual rainfall 110 inches.

BATH GARDEN.

The Bath garden, forty-four miles east of Kingston, is situated in one of the most tropical districts in the island. In other places, *e. g.*, in Hanover, it could easily be imagined that the road led through some English park, until we perhaps notice the sensitive plant (*Mimosa pudica*) trailing amongst the grass, or come upon a gigantic ceiba tree with buttressed trunk and its branches stretching far and wide loaded with a whole garden of exotic epiphytes. But in the Bath district the luxuriance of the vegetation arrests the attention on all sides. The street of the village has an avenue of the Otaheite apple (*Eugenia malaccensis*), which carpets the road with its purplish-red stamens. *Spathodea campanulata*, a large tree with reddish-orange flowers, from tropical Africa, has become quite naturalized. The upas tree and the durian both grow in the garden, as well as the talipot or umbrella palm of Ceylon (*Corypha umbraculifera*), which has fan-shaped leaves twelve feet in diameter.

The sea is only six miles off, where there is a large sheltered bay of shallow water, protected by a bold headland and small bays, where search may be made for marine algæ.

About a mile and a half from the village, by a road aiong thc side of the gorge, we come to the famous bath dedicated to St. Thomas the Apostle. It is a hot spring of mineral water, efficacious in rheumatic and gouty complaints. This gorge is an unfailing delight for its picturesque beauty, and the botanist finds something new at every step. There is a bridle path across the mountains to Port Antonio, sixteen miles distant by the Cuna-cuna pass. This pass is an easy ride of six and one-half miles from Bath through virgin forest.

The forest commences close at the north side of the village. Most of it at one time or another has probably been cut for negro provision fiel ls, but at a distance only of two or three miles undisturbed forest can easily be found, where the palm, *Calyptrogyne Swartzii*, flourishes, its stems clothed with that rare tropical American fern *Anetium citrifolium.* The John Crow, or Blake mountains, are unknown land, and

it is said that the Maroons alone penetrate into their fastnesses in hunting wild pig. Inspector Thomas of the Jamaica constabulary crossed them a few years ago, and published an account of his expedition, but he is the only white man who is actually known to have ventured into them. These limestone mountains are of some considerable elevation (about 2000 feet), and are only ten miles from Bath, seven miles of which can be ridden. They ought to prove a happy hunting ground for the botanist. There are specimens of two species of tree fern, *Cyathea conquisita* and *C. pendula* in the British Musium, collected by Nathaniel Wilson who lived at Mansfield, two miles from Bath, but they have never been found since, and it is quite possible that he may have come across them near the John Crow mountains where no botanist has ever been since his time. The soil at Bath is alluvial, deep and rich. The rainfall is heavy, being on the borders of the district which is classed by Maxwell Hall as having the heaviest fall, viz., over 100 inches in the year.

The garden is only a remnant of Nathaniel Wilson's garden, but is maintained by government as a small arboretum. It contains several trees of great interest and beauty, and is much more tropical in its aspects than any of the other gardens. Elevation 70 feet; mean annual temperature 78° F.

THE FLORA.

Jamaica is a paradise for the botanist, whether he specialises in algæ fungi, mosses, ferns, or flowering plants. Of ferns there are about 450 species, and of flowering plants 2180 species; a number of both are endemic. Among the flowering plants are not only those found everywhere in the tropics, but types from North, Central and South America and the other West Indian Islands.

Forty-four new species of mosses from a limited area in the Blue Mountains have just been described in *Bulletin de l'Herbier Boissier*. A synopsis of the ferns is now appearing in the *Bulletin of the Botanical Department, Jamaica*. Grisebach's *Flora of the British West Indies* is the only book that gives a connected account of the flowering plants. The flora of the whole of the West Indies is being thoroughly worked up now by Professor Urban, assistant director of the botanic garden of Berlin. The results of his labours appear in Engler's *Botanische Jahrbücher*. The monographs in continuation of De Candolle's *Prodromus* also contain later works than Grisebach's. In the *Jahrbuch* of the botanical gardens of Berlin Dr. Mez has published a monograph of the American Lauraceæ including those of the West Indies.

Elevations.

The following table gives a general idea of the area in square miles embraced in the different zones of elevation, above sea level, in the several parishes.

Parishes.		Area below 1000 feet.	1,000 feet to 2,000 feet.	2,000 feet to 3,000 feet.	3,000 feet to 4,000 feet.	4,000 feet to 5,000 feet.	5,000 feet and upwards.	Total areas in square miles.
Kingston	...	6½	⅔	...	...	...	...	7⅙
St. Andrew	...	59	54	27	17½	8	½	166
St. Thomas	...	135	59	35	20	14	11	274
Portland	...	94	89	40	32½	17	12½	285
St. Mary	...	110	116	19	4	...	...	249
St. Ann	...	85	337	54	...	...	...	476
Trelwany	...	166	135	32	...	...	...	333
St. James	...	139	90	5	...	...	...	234
Hanover	...	161	6	...	...	...	...	167
Westmoreland	...	235	73	...	...	...	...	308
St. Elizabeth	..	335	120	7	...	...	...	462
Manchester	..	42	134	126	...	...	...	302
Clarendon	..	314	115	45	...	...	...	474
St. Catherine	...	336	124	10	...	...	...	470
Totals	...	2,217½	1,452⅔	400	74	39	24	4,207⅙

Year.		Rainfall Divisions				The Island.
		N.E.	N.	W.C.	S.	
		In.	In.	In.	In.	In.
1870	.	110.60	83.09	102.98	61.07	89.43
1871	.	69.45	41.88	54.56	34.46	50.09
1872	.	59.42	40.79	51.50	29.02	45.18
1873	.	84.08	52.64	67.79	47.71	63.06
1874	.	97.18	68.25	62.97	47 35	68.94
1875	.	71 89	47.15	56.16	34.47	52.42
1876	.	90.38	54.71	87 33	52.99	71.35
1877	.	100.72	56.53	64.06	52.27	68.40
1878	.	104.12	62.99	72.44	66.11	76.42
1879	.	122.55	65.44	87.54	79.85	88.84
Means	.	91.04	57.34	70 73	50.53	67.41
1880	.	76.37	47 01	64.91	33.47	55.44
1881	.	91.24	49.42	75 32	58.42	68.60
1882	.	65.48	43.76	78.59	43.66	57.87
1883	.	72.30	41.52	78.19	45.02	59.26
1884	.	69 00	41.87	73 10	43.73	56.90
1885	.	70.55	52 77	72.62	43.52	59 86
1886	.	126.61	60.98	88.21	86.64	90.61
1887	.	80.25	61.07	80.14	61.16	70.66
1888	.	98 00	54.42	70.43	65.58	72 11
1889	.	99.81	56 82	75.94	54.02	74.15
Means	.	84 96	50.96	75.74	54.51	66.54

RAINFALL.—JAMAICA RAINFALL FROM 1870 TO 1889.

Year.	Jan.	Feb.	Mar.	April	May	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
1870 .	3.99	4.35	3.10	2.79	17.38	3.58	4 33	5.72	8.05	16.74	12.50	9.90	89.43
1871 .	2.40	1.60	2.29	3.46	6.43	1.98	3.79	3.46	5.70	8.88	5.88	4.22	50.09
1872 .	3.00	2.84	3.06	2.06	5.18	2.41	2.89	5.24	4.55	6.09	3.13	4.73	45.18
1873 .	8.15	1.94	5.47	1.15	5.06	2.58	2.56	7 51	10 73	8.57	3.53	5.81	63.06
1874 .	3.44	2.20	0.61	4.40	10.65	3.96	2.51	9.65	6.82	11.69	10.52	2 49	68.94
1875 .	2.57	0.67	2.59	3.05	8.54	3.74	3.87	5.13	7.60	5.58	2 34	6.74	52.42
1876 .	6.00	0.96	1.63	4.68	8.24	5.40	8.15	5.06	5.19	11.36	8.96	5.72	71.35
1877 .	5 94	1.18	5.38	2.91	15.03	6.50	4.68	1.76	5.01	4.90	7.63	7.88	68.40
1878 .	6.35	2.18	2.78	0.70	4.86	6.63	5.85	10.80	7.43	11.20	7.32	9.61	76.42
1879 .	2.81	5.30	6.49	7.28	9.14	10.64	4.47	12.32	7.38	15.96	5.29	1.75	88.84
Means .	4.46	2.38	3.34	3.25	9.05	4.74	4 31	6.66	6.85	10.07	6.71	5.59	67.41
1880 .	4.36	0.96	1.10	2.77	11.60	3.09	3.86	9.58	3.97	4.00	2.21	7.94	55.44
1881 .	1.22	4.01	1.30	4.63	10.28	5.56	4.77	6.21	7.68	12.08	7.52	3.34	68.60
1882 .	2.92	1.93	3.54	3.32	8.22	2.33	3.76	4.80	8.78	8.96	5.36	3.95	57.87
1883 .	5.49	3.50	4.08	3.34	5.29	4.98	3.15	5.42	7.82	8.15	5.12	2.92	59.26
1884 .	4.72	3.44	2.51	1.85	6.72	6.89	2.52	5.06	6.23	9.52	5.00	2.44	56.90
1885 .	1.73	1.49	1.47	4.73	4.90	3.32	3.02	6.19	6.22	6.37	4 74	15.69	58.86
1886 .	5.23	4.65	2.68	6.39	5.30	23.36	6.22	13.54	5.90	7.98	3.70	5.66	90.61
1887 .	6.02	2.32	2.38	4.47	9.32	8.89	7.19	6.91	5.77	8.47	8.17	0.75	70.66
1888 .	1.36	1.89	1.70	3.61	21.24	6.77	2.65	5.47	8.10	4.38	4.59	10.35	72.11
1889 .	4.78	0.90	4.19	6.71	7.82	12.52	6.08	5.12	8.20	10.49	4.37	2.97	74.15
Means .	3.78	2.51	2.49	4.18	9.07	7.77	4.32	6.83	6.87	8.04	5.08	5.60	66.54

NOTES ON ORCHIDS AT HOPE GARDENS.

Dendrobium formosum, Roxb., var., *giganteum*, Hort.—First introduced to European gardens from the Khasia Hills, in 1837. It is widely distributed over north-eastern India and Burmah. In British Burmah the native women use the flowers to adorn their hair. It is also a native of the Andaman Islands, and some of the very finest forms are found in mangrove swamps along the sea coast, where the plants are washed by sea-spray during stormy weather. In these islands there is rain during eleven months of the year, so that the plants have practically no resting season. This is the largest-flowered, and finest of the white Dendrobiums. The flowers are produced towards the ends of the leafy stems, usually in clusters of 3 to 5; the individual flowers are about 4 inches across, of the purest white, save an orange-yellow blotch on the lip; the sepals are lance-shaped and pointed, the petals almost as broad as long, blunt; the lip has a large tongue-like spur.

Dendrobium Phalænopsis, Fitzg.—This fine Dendrobium is a native of North Australia and New Guinea. The flowers latter are about 3 inches across, the sepals lance-shaped and pointed, varying in colour from pure white to rosy-mauve; petals twice as broad as the sepals, rosy-lilac or purplish-mauve in colour, lip three-lobed, maroon-purple.

Lælia rubescens, Lindl.—This pretty little orchid is a native of Southern Mexico and Guatemala, and the inhabitants of the last named country think so highly of it that they call it "Flor de Jesus." The scape is about 12 inches high, and bears at its summit a loose raceme of 5 flowers. The latter are about 2½ inches in diameter rosy-lilac in colour.

Broughtonia lilacina, Henfr.—This beautiful orchid is a native of Jamaica, Cuba and San Domingo. The scape is 15 to 30 inches long, producing at its summit 5 to 9 flowers, each about 2 inches across, and in colour pale rosy-mauve with purple veins and marklings. This has been known for long as "Læliopsis domingensis."

Oncidium Papilio, Lindl.—This is the Butterfly Orchid of Trinidad remarkable for the appearance of its flowers. The central lobe of the lip is of a canary-yellow colour with a bright red marginal band. The side lobes are small but from below them the lateral sepals spread down wing-like, with wavy margins almost surrounding the lip; they are bright chestnut-red crossed by yellow bands. Above are three long and narrow appendages of the "Butterfly," the central one being the third sepal, and the two others the petals.

Oncidium Kramerianum, Reichb.—This is considered by many as merely a variety of O. Papilio, but others point out various structural differences which are considered sufficient to separate the two, such as the upper sepals and petals are shorter and differently coloured. It is a native of the Andes of Ecuador and New Grenada,

Calanthe Veitchii, Lindl.—The genus Calanthe includes over forty species widely distributed over the tropical and sub-tropical regions of the Eastern Hemisphere and occurring also very sparingly in Mexico, Central America and the West Indies, "Calanthe mexicana" being found in Jamaica. The Calanthes are most numerous along the lower

Himalayas from Assam to Nepal, and again in Java. The plant above named is a garden hybrid, raised by Messrs. Veitch at their Exeter nursery in 1856. The parent plants were C. rosea, Benth. and C. vestita, Lindl. The scape is about two feet high, and 8 to 12 flowered. Flowers about 2 inches across, bright rose colour, with a white spot at the base of the lip.

Cypripedium Sedenii, Rchb.—This is one of the "Lady's Slipper" orchids. The plant under notice is the garden hybrid known as "candidulum." The sepals and petals are white, the former with pale yellow-green veins, and the latter with a faint flush or pale rose towards the tips, lip pale rose.

FERNS: SYNOPTICAL LIST—XLIX.

Synoptical List, with descriptions, of the Ferns and Fern-Allies of Jamaica. By G. S. JENMAN, *Superintendent Botanical Garden, Demerara.*

1. *Acrostichum Herminieri*, Bory.—Rootstock short, densely clothed with matted linear or filiform, undulate, bright ferruginous scales, which are a third to 1 in. l. and $\frac{1}{4}$ li. w.; fronds several, scimiter-shaped, tufted or subtufted, quite pendant, tapering and long-decurrent at the base to stipites an inch or less long, tapering and acuminate at the apex $1\frac{1}{2}$ - 3 ft. l., $\frac{3}{4}$ - 1 in. w., very coriaceous, dark glossy green, paler beneath, glabrous but with scattered minute speck-like scales beneath while young; midrib immersed in the parenchyma; veins close, forked, immersed, evident above, less so or concealed beneath; fertile fronds 4 - 5 in. l. $1\frac{1}{4}$ - $1\frac{1}{2}$ in. w. lanceolate or lanceolate-oblong, shortly pointed, the base cuneate; petiole about 1 in. l.

Infrequent on trees in forests of the eastern parishes; gathered in 1886 by Mr. Sherring above Bath, at 4000 ft. altitude; a peculiar and very striking species distinguished by the very long narrow sterile fronds, over a yard long often not exceeding an inch wide, and the very disproportional short but rather broader fertile ones, that rarely exceed six inches long. Though very coriaceous, the fronds, which curve laterally, owing to one margin being shorter than the other thus acquiring scimiter-shape, are not so rigid as in some of the other species. The rootstock is short repent or subrepent descending, and quite concealed in the copious tuft of long dense glossy scales.

2. *A. gramineum*, Jenm.—Rootstock slender, creeping, naked, but viscid; stipites nude, scattered but approximate, slender, 2–3 in. l. winged in the upper part by the decurrent sides of the fronds, fronds numerous, erect or spreading somewhat forming grass-like patches, linear, $2\frac{1}{2}$–5 in. l. 3–4 li. w., tapering equally at the apex and base, or more so at the latter, chartaceous, pellucid, naked, glossy, bright green, viscid throughout; veins rather close, simple and forked, terminating within the margins in clavate apices; fertile fronds smaller, the same shape, on longer stipites, Journ. Bot. 1879, p. 263.

Common on banks and rocks at 2,000 ft. alt.; gathered near Second-breakfast Spring, beyond Mt. Moses, St. Andrew. A smaller and much thinner textured plant than the next, naked in all its parts, very viscid,

which however only shows when pressed in paper to dry, and forming large patches, and in substance quite distinct from all the rest of this section.

3. *A. simplex*, Swartz.—Rootstock slender, short-creeping, clothed with small very dark lanceolate-acuminate scales; stipites erect, contiguous, 2 - 3 in. l. slightly scaly at the very base; fronds linear-lanceolate, erect, tapering equally at both ends, very acuminate, the base decurrent on the petioles, $\frac{1}{2}$ - 1 ft. l., $\frac{1}{3}$ - $\frac{2}{3}$ in. w., very coriaceous and stiff, naked, the upper side glossy dark green, under paler, the margins reflexed when dry, the rachis prominent beneath; veins obscure, close, simple or forked; fertile fronds usually somewhat smaller, though as broad, acute at the apex, the stipites rather longer—Hook. Gen. t. 105. A.

a. A. martinicense, Desv.—Fronds linear, 10 - 15 in. l. 2 - 4 or 6 l. w. very numerous; rootstock more slender; upper surface with a blueish-green tinge, under pale and at first sprinkled with a few minute appressed scales; fertile fronds shorter and broader.—Hist. Acrost. p. 45 t. 16. f. 3.

Infrequent on decaying logs in forests and coffee plantations at 2000 - 4000 ft. altitude. This is not nearly so abundant as the following allied species from which it is distinguished by its narrow linear-lanceolate fronds. *a* occupies the trunks and branches of growing trees chiefly in moist forests up to 4000 ft alt. and is much more common. Though equally coriaceous it is usually pendant or much curved in habit. and the rootstock interlaces, forming patches as large or larger than one's outspread hands, with numerous densely aggregated fronds.

4. *A. inæqualifolium*, Jenm.—Rootstock free-creeping, cylindrical, thick as a quill, horizontal, densely clothed with chesnut coloured pale-margined paleæ; stipites scattered, erect, 2–3 or 4 in. l,, rather freely clothed at first with spreading scattered brown scales, subsequently naked; fronds stiffly erect, linear lanceolate, very acuminate, tapering equally to the apex and base, 4–10 in. l. $\frac{1}{3}$rd–$1\frac{1}{4}$ in. w, coriaceous, dark bright green, paler beneath, dotted with scattered very minute fimbriate pale-edged scales, which are paler, less abundant and more fibrillose on the upper surface; margins cartilaginous-edged, and rather reflexed when dry; veins fine, forked from the base, close obscure; fertile fronds conform but on stipites, which are more or less distinctly scaly, usually twice as long as the barren.—Journ. Bot. 1886, p. 273.

Frequent in high mountain forests on logs and decaying vegetable matter; like *chartaceum* with which it grows, in colour, but uniformly smaller, much stiffer and coriaceous, the minute scales of the surface more fibrillose and paler, the petioles freely palaceous at first, the fertile ones always so while the fronds are fresh, and twice the length of the barren, and with a slender free-creeping horizontal rootstock, by which it can always be distinguished, several inches long, dark coloured and with a double series of the bases of past stipites $\frac{1}{2}$–$\frac{3}{4}$ in. l. on the upper-side.

5. *A. alatum*, Fée.—Rootstock shortly repent, freely clothed with dark or ferruginous reticulated, fine, acuminate scales; stipites approximate or sub-tufted, erect, $1\frac{1}{2}$–4 in., l. slightly scaly or naked; fronds erect, oblong-lanceolate, or lanceolate, acuminate, the base decurrent as wings to the upper part of the stipes, subcoriaceous, dark green,

glabrous, 3–7 in. l. 1½–2in. w. glabrous or sprinkled beneath with very minute speck-like scales ; veins patent, ½–1 li. apart, simple and forked, evident; fertile fronds much reduced, less decurrent, on much longer slender stipites overtopping the sterile.—Fée Mem. pl. 5, fig 2. Infrequent in mountain forests of St. Andrew at 2,000 3,000 ft. altitude. Differs from *conforme* and other allied species by the decurrent base of the fronds which wings with membrane the upper part of the petioles, and by the smaller long petioled fertile fronds which are projected quite above the tops of the sterile ones.

6. *A. viridifolium*, Jenm.—Rootstock short, rather stout, oblique or decumbent, densely clothed with small feruginous linear scales : stipites subtufted, erect straminous, 1 - 3 in. l. channelled; fronds linear-lanceolate, 7 - 9 in. l. 1 - 1⅓ in. w. tapering both up and down, but more downwards and passing insensibly into the petiole, the apex pointed but obtuse, glabrous, but with laxly scattered very minute peltate scales over the underside, coriaceous, bright green; margin even or repand; veins fine, close, once forked, nearly concealed : fertile fronds much narrower, nearly or quite as long, on stipites twice as long.—Journ. Bot. 1886, p. 273.

This comes nearest to *A. flaccidum*, Fée, but is distinguished by its longer petioles, coriaceous texture, finer and closer venation, and the obtuse pointed fronds. The petioles are slightly scaly at first, but early become quite naked. The midrib is prominent beneath, channelled above, and with the petioles straw-coloured when dry.

CONTRIBUTIONS AND ADDITIONS.

Library.

Bulletin R. Gard. Kew App. III, 1897, I, 1898. [Director.]
Bot. Mag. Dec. 1897, Jan. 1898. [Purchased.]
Trop. Agriculturist Nov. & Dec. 1897. [Purchased.]
Sugar Cane. Dec. 1897. Jan. 1898. [Editor.]
Sugar. Nov. & Dec. 1897 & Jan. 1898. [Editor.]
Pharm. Journal. Dec. 1897.
W. I. & Com. Advertiser. Dec. 1897. Jan. 1898. [Editor.]
Chemist & Druggist. Nov. & Dec. 1897. [Editor.]
Produce World. Nov. & Dec. 1897. [Editor.]
Botanical Gazette. Dec. 1897. Jan. 1898. [Editor.]
British Trade Journal. Nov. Dec. 1897 & Jan. 1898. [Editor.]
Agr. Ledger. Nos. 9 & 17. 1897. [Supt. Govt. Print. Calcutta.]
Journ. Board of Agr. England. Dec. 1897 & Jan. 1898. [Board.]
Pro. Agr. Soc. Trinidad. Sept. Oct. 1897 & Jan. 1898. [Secretary.]
Meteorlogical Return Bot. Gard. St. Vincent. Nov. Dec. 1897.
Bulletin Bot. Gar. Trinidan. Jan. 1898. [Supt.]
Barbados Planters Monthly. Jan. 1898. [Editor.]
Agr. Gazette, N. S. Wales. Sept —Nov. 1897. [Dept. of Agr.]
Sugar Journal. Oct. & Nov. 1897. [Editor.]
Agr. Journ. Cape of Good Hope. Oct.—Dec. 1897. [Dep. of Agr.]
Central African Times. Oct.—Dec. 1897. [Editor.]
Bulletin Torrey Bot. Club. Nov. & Dec. 1897. Jan. 1898. [Editor.]
American Journ. of Pharm. Dec. 1897. Jan. 1898. [Editor.]
Evidence of Dr. William Saunders on Agri & Colonization. May 1897. [Author.]
Nova Scotia Prov. Govt. Crop. Report Nov. 1897. [Director.]
New Natal Plants I. Extr. *Journ. Bot.* Sept. 1897. [Author.]
Control & Fixation of Shifting Sands. By John Gifford. [Author.]
Notes on Zamia and Ginkgo by H. J. Webber Extr. *Bot. Gaz.* Oct. 1897. [Author.]
Flora of British India. Vol. 7 Pts. 23, 24. By Sir J. D. Hooker. [Dirctor, Kew.]

Annals of Botany. Dec. 1897. [Purchased.]
Treatise on Sugar Cane. Vol I. By W. C. Stubbs. [Author.]
Times of Ceylon. Nov. & Dec. 1897. [Editor.]
Queensland Agr. Journ. Sept.—Dec. 1897. [Director.]
Report on Gardens of Oodeypore. 1897. [Supt.]
Pro. Agr. Hort. Soc. Madras July—Sep. [Secretary.]
Circular R. Bot. Gard. Ceylon. July, Aug. & Nov. 1897. [Director.]
Forester. Dec. 1897. [Editor.]
Montreal Pharm. Journ. Dec. 1897 & Jan. 1898.
Canadian Entomologist. Dec. 1897.
Publications Field Columbian Museum. [Curator.]
Report Dept. of Agr. Canada 1896. [Director.]
John Hopkins Univ. Circulars. Nov. 1897. [President]
Trans. Acad. S. E. St Louis. [Secretary.]
Annual Report Bot. Sta. Sierra Leone. 1896. [Curator.]
Journ Botany. Dec. 1897. Jan. 1898. [Purchased.]
Hawaiian Planters Monthly. Nov. 1897. [Editor.]
Sucrerie Indigene et Coloniale. Nov. & Dec. 1897. [Editor.]
Proefstation Seukerriet. W. Java. 1897. [Editor.]
Bulletin de L'Herbier Boissier. Nov. & Dec. 1897.
Garden. Jan. 1898. [Purchased.]
Gardeners Chronicle. Jan. 1898. [Purchased.]
Journ. Jamaica Agr. Soc. [Secretary.]
Contributions to Flora of Queensland. F. N. Bailey. Ext. *Queensland Agr. Journ.* [Author.]
Bulletin Bot. Gard. & Museum, Berlin Dec. 1897.
Pamphlets by J. N. Lloyd. [Author.]
Amsterdam, Kol. Mus. Nuttige Ind. Pl. IV. Greshoff & Boerlage. 1897.
Reports, Bulletins & Records from the following Agricultural Experiment Stations, U. S. A.
Vermont, Texas, Arizona, Virginia, New Hampshire, California, Idaho.
Nebraska, Georgia, Utah, Maryland, Rhode Island, Ohio, Kansas.
Pennsylvana, New Jersey, Wyoming, N. York (Geneva).

Plants.

From Royal Gardens, Kew.—
Tubers of Oxalis crenata

Seeds.

From Lady Blake, Moneague.—
Cleome speciosa
From Dr. Morris, Kew.—
Double yellow Datura
From Secretary Agri-Hort. Society, Madras.—
Acacia Sundra
Cordia Rothii
Ficus racemosa
Anogeissus acuminata
Dalbergia frondosa
Cassia marginata
Mimusops Elengi
Pterospermum suberifolium
Calophyllum inophyllum
Bassia longifolia
Pongamia glabra
From Botanic Gardens, Demerara.—
Triplaris surinamensis
From Royal Botanic Gardens, Trinidad.
Clavija ornata
Musa sumatrana

From Hugh Dixson, Sydney, N.S.W.—
Stevensonia grandifolia
From Technological Museum, Sydney, N. S. W.—
Ochrosia Poweri
Pittosporum rhombifolium
Endiandra discolor
Cryptocarya glaucescens
From Mr. R. B. White, Colombia.—
Ceroxylon andicola, occidentalis
From Mr. W. Jekyll, Robertsfield.—
Hibiscus Sabdariffa
From Mr. J. V. Sigvald Mueller, Guayaquil, Eucador.—
Papaya Chongona
Solanum quitoense
From Secretary Colonia Cosme, Paraguay.
Solanum sysimbrifolium
From The Royal Gardens, Kew.—
Heterospathe elata
Pitcairnia ferruginea.

New Series.] FEBRUARY, 1898. Vol. V. Part 2.

BULLETIN

OF THE

BOTANICAL DEPARTMENT, JAMAICA.

EDITED BY

WILLIAM FAWCETT, B.Sc., F.L.S.

Director of Public Gardens and Plantations.

CONTENTS:

PRICE Threepence.

A Copy will be supplied free to any Resident in Jamaica, who will send Name and Address to the Director of Public Gardens and Plantations, Kingston P.O.

KINGSTON, JAMAICA:
GOVERNMENT PRINTING OFFICE, 79 DUKE STREET.

1898

JAMAICA.

BULLETIN

OF THE

BOTANICAL DEPARTMENT.

New Series.] FEBRUARY, 1898. Vol. V. Part 2.

COCOA IN TRINIDAD, VENEZUELA AND GRENADA.*

Notes by a Visitor in January and February, 1897.

TRINIDAD.

General Remarks on Cultivation.

IN the oldest Cocoa growing districts, these estates are situated in the valleys formed by the ridge of hills running along the north of the Island parallel to the coast.

The soil in these valleys was said by many planters to be getting exhausted, and to be giving poorer crops than some of the newer lands opened up more recently.

The centre of the Island has been opened up within the last 20 years, and at the present time, there is a great quantity of young Cocoa just coming into bearing.

It is said to be the richest and most productive part of the Island, the Cocoa estates situated here giving a higher return per tree than elsewhere.

This is a slightly undulating district, and the hills and valleys are clothed with Cocoa trees

Varieties of Cocoa Grown.—The varieties of Cocoa grown in Trinidad are the Criollo, Forastero and Calabacillo.

The quality of the Criollo Cocoa is better than that of the Forastero, and the Forastero is again better than the Calabacillo variety.

Formerly the Criollo Cocoa was grown in Trinidad, but some 100 years ago, a blight destroyed nearly all the trees, and these were replaced by the hardier Forastero variety from the Main, (probably they would come from the district round Carupano).

The Calabacillo is the commonest kind of Cocoa grown, it is the hardiest variety of tree and gives the largest yield.

* For general information consult: Cacao, how to grow and how to cure it By Dr. Morris. Price 6d. Published by the Institute of Jamaica.

* Cacao. By J. H. Hart. Price 5/. Govt. Printing Office, Trinidad. See also *Bulletin* 1895 (pages 38, 180); 1896 (page 15).

The Criollo variety gives the smallest yield of the 3 varieties, and the tree is more subject to disease than the other two.

Whilst these 3 varieties exist in Trinidad, the bulk of the trees are strains of the Forastero and Calabacillo, the Forastero variety largely predominating.

In Grenada the Calabacillo predominates ; in the west of Venezuela the Criollo is grown.

The various varieties of Cocoa are distinguished by the pods and seeds, the shape of the pods and the size of the seeds.

The Calabacillo has a small round pod—the Criollo a long narrow one—the stalk end being constricted. The Forastero has a long pod without the constriction. The beans of the Criollo Cocoa are round and thick, and when cut are white in the centre and of a sweet flavour. Those of the Forastero are not so round, and flatter than the Criollo beans and when cut, have a purple colour, and bitter taste.

The Calabacillo beans are smaller, flatter and more purple than the Forastero beans. When these beans have been fermented and dried, the Criollo is of a light brown colour, the Forastero a dark brown, the Calabacillo a purple colour. The "break" of the Criollo Cocoa is better than that of the Forastero, whilst the Calabacillo has a more "slatey" appearance when cut across The commoner varieties of Cocoa require longer fermentation to make them at all palatable (i.e. to remove the bitter taste).

All the varieties of Cocoa bear both red and yellow pods this being no indication of the quality of the Cocoa.

The value of the Cocoa depends upou

(1) The variety of the tree from which the beans are gathered.

(2) The method of fermentation adopted by the planter.

(3) The quality of the soil on which the Cocoa is grown.

The very finest flavoured Cocoas can only be grown on certain soils.

One planter attributed the quality of his Cocoa to the care that was taken in the selection of the trees and the difference in quality between his and another estate was due to this fact, as they are both grown in the same valley on contiguous estates.

The Criollo Cocoa had been tried, but it was difficult to grow, and the yield was small, consequently the trees had been pulled up.

Seeds have been taken from the trees grown in the Ocumare and Choroni Valleys of Venezuela and planted in other parts of Venezuela and Trinidad, but have not given Choroni Cocoa, and trees from other districts planted at Ocumare in 4 generations produced Ocumare Cocoa.

However, one must not forget that there is only 1-16th of the original strain of Cocoa, if the tree is planted at Ocumare surrounded by trees of the true Criollo type.

Probably it would be safe to say one could grow Cocoa in any West Indian Island, like the average Cocoa produced in any part of the world, but not equal to the best of any particular kind. It would be necessary to take seed from the variety of Cocoa one wanted to imitate, ferment it in exactly the same way, and to take care the flower was not crossed by any local variety growing near.

Formation of an Estate.—The estates in Trinidad are nearly all formed by contractors. That is to say the planter gives a certain portion of his land to a contractor, generally a negro, who clears it and plants the

Cocoa trees. He grows plantains and ground provisions between the young Cocoa trees for his own use or for sale.

At the end of five years he hands the land back again to the owner, who gives him 80 cents or $1 per tree, according to the arrangement made.

A single contractor generally planted 1,000 trees.

Some planters supply the contractor with seeds but generally they are left to provide their own

When we were in Trinidad, the planters said it did not pay to take the trees over so soon, and some left them with the contractor a year or two longer.

The advantages of the system are its cheapness, but the disadvantages are that unless the contractor is supplied with seed and well looked after, he will put in a common and hardier variety of plant, as it is easier to grow.

Arrangements of an Estate.—The Cocoa trees are planted in lines, some 12 feet apart, whilst every 36–40 feet the Bois Immortelles are planted. In the hilly districts where the Cocoa trees are planted on the steep hillsides they are placed closer together and fewer shade trees are employed. This method of planting seemed generally employed throughout the Island, though of course some estates were better lined out than others.

One planter thought a better yield might be obtained per tree by planting the trees further apart.

The Bois Immortelles were used in nearly all cases as shade, though in some places the sand box tree was used instead.

The timber of the Immortelle is valueless, but it has always been found to be the most successful shade tree by the planters.

The manager's or owner's house is generally situated in the centre of the estate and is surrounded by the sweat boxes and drying sheds.

Kind of soil, adapted for the Cocoa estate is a light, loamy one; sandy soil gives a better quality Cocoa than heavy ones. It is essential that the soil should be of some depth.

All the planters in Trinidad said it was not worth while planting old sugar estates, as the soil had been exhausted by the sugar, and as there was plenty of virgin soil to be obtained, it was better to clear fresh land than plant that partly exhausted.

Work on an Estate.—This consists, after it has been handed over by the contractor, in the careful weeding of the ground, the pruning of the trees, the gathering, breaking, fermenting and drying the Cocoa. There is work on an estate all the year round, as the men are employed in pruning and weeding when the picking is over.

Thus a small body of men are constantly employed, and there is no necessity for a large amount of labour at one time, and neither is a very large amount of labour required as on a sugar estate.

Gathering Cocoa.—This is done by the men who cut off the Cocoa pods within easy reach by means of a machette: those higher up they remove by means of the Cocoa hooks which are mounted on long bamboo poles. The Cocoa hook is sharpened at the tip and on the under side of the hook, so that the Cocoa can be gathered by means of a thrust or a pull.

The pods are known to be ripe by their colour, some being green, others red. It is not easy to say at first when they are quite ripe, but the men employed soon gain experience and are enabled to tell by the appearance.

When the pod is cut open it is easy to tell whether it is ripe, as in a ripe pod the beans are separated from the shell, but they adhere to it before ripening.

The Cocoa gatherers leave the pods upon the ground where they fall. Women are employed to collect them into baskets.

The women deposit the pods into large heaps at different parts of the plantation.

Breaking Cocoa.—This consists in cutting open the pods and removing the beans. A planter told us that it improved the quality of the Cocoa to leave pods a few days in the heaps on the ground before "breaking," but he said that he always had the Cocoa broken as soon as it was gathered, to prevent it being stolen in the night.

In the other plantations we visited it was generally left three or four days in the heaps on the ground before "breaking."

If the Cocoa is left too long in this manner, it will ferment and go mouldy.

When "breaking" the Cocoa the men take a short knife (*i.e.* a machette with the end taken off) and cut the pod in two throwing the top half on one side and the bottom half (to which the placenta with the beans is attached) into a basket. The beans are removed from the bottom half of the pods by means of little wooden spoons and put into large wicker baskets.

This part of the process is performed by women.

These baskets are emptied into the panniers of the ponies which take the Cocoa to the sweat boxes. Whilst breaking on the best estates the black and decayed beans are put on one side and not mixed with the good Cocoa.

Sweat Boxes.—These on one estate were large wooden troughs with a cement bottom some 6 feet square and 4 feet deep arranged in sets of 12 under one roof, there being an opening between the top of the boxes and the roof, and sufficient space between the bottom of the box and the ground to allow of the juices liberated during fermentation to escape. A rack is put at the bottom of the box and when it is filled with Cocoa, banana leaves are spread over the top with sometimes a lid over all and most of the sweat boxes we saw were arranged on the same principle. Some had fewer divisions.

The boxes on another estate that they were using held from 30 to 40 bags of Cocoa.

On another the fermenting troughs were arranged somewhat differently. There were 6 side by side with a door opening into each box.

Fermentation.—The method of fermentation was the same all over Trinidad with some slight differences. The difference between an estate mark and a common Trinidad is mainly in the fermentation, the better Trinidad Cocoa being fermented the longest of all.

One planter only fermented 5–8 days. The Cocoa on another estate was fermented 10–12 days, being turned over two or three times. During fermentation the white pulp which surrounds the beans is largely

removed—part being used in the process, and part draining away as a liquid at the bottom of the troughs.

The bean itself is split up into a granular structure. Unfermented dried beans when cut open are slatey, whilst the fermented have the cellular structure.

According to some planters the maximum heat developed was 120°. They said it took 5 or 6 days to develop this heat, and then the temperature of the mass cooled down.

Another said he had tried a thermometer in his fermenting boxes, and had come to the conclusion that if the temperature rose above 130° the Cocoa was spoilt. He thought the fall in temperature at night had a harmful effect, and suggested that steam pipes in the boxes might obviate this.

On one estate the Cocoa was turned over every three days from one box into another, this being turned over four times during the process of fermentation.

On other estates where they did not ferment so long, the Cocoa was not turned over so many times, but it seems to be a pretty general rule after three or four days to open the "sweat" boxes and to turn the Cocoa over. If this process is not carried out, the Cocoa in the centre of the box becomes too hot, whilst the Cocoa on the outside is not sufficiently fermented.

Drying Cocoa.—When the Cocoa has been fermented a sufficient length of time, it is spread out upon the drying tables. These are large raised floors some 60 feet by 30 feet wide with a movable roof. The roof is in two parts and is made so that it can be slid out at either end of the drying shed (upon rails) thus the Cocoa can be exposed to the sun during the day, but at night-time, or when it rains, the roofs are rolled back again over the floor. There is a door at the end of the gable, to enable the men to get inside to push the roof off. These roofs are always made with a lock, so that the Cocoa, at night, can be kept safe from thieves.

When the Cocoa is first spread upon the table it is of a whitish brown colour and very moist. During the process of drying, the pulp shrivels up and the exterior of the bean acquires the brown colour of the Trinidad Cocoa we see on the London Market. The interior also become darker in tint, the Calabacillo Cocoa dries a dark brownish purple. No fermenting will give Calabacillo Cocoa the brown tint of a good Forastero or Criollo Cocoa.

A planter said it took three to six days to dry the Cocoa. It depended, of course, upon the weather, as, if there was a prolonged rain and the sheds could not be opened, it took longer than if the weather were fine. The Cocoa is covered up also if the sun is too hot, as it blisters the skin, and appearance is not so good in consequence.

There is generally an old coolie or negro in charge of the drying floors, who pulls the roof over them when it rains or when the sun is too hot, and spends his time while the sheds are open in turning the Cocoa, that is, shuffling up and down the drying shed and turning the Cocoa over with his bare feet.

If the Cocoa were bagged up and shipped after simply drying in this way, it would have a somewhat mildewed appearance.

In order to get the bright gummy look of the best estate Trinidad

Cocoa, the beans are piled into small heaps on the drying tables, in the early morning, and are "danced" by the coolies, that is, five or six of the men and women walk in a little ring on the top of this heap rubbing the Cocoa together with their feet; on some estates this is done every morning till the Cocoa is dry. On one estate. this was left until the last morning, when the skins of the Cocoa were slightly moistened with water, a little red sand being added to the water after which the Cocoa was "danced" spread out again on the floor and finally dried. We did not see in Trinidad any satisfactory artificial dryers. We were informed that several had been tried, but a satisfactory one had not yet been made.

Picking and Sorting.—On the best estates in Trinidad, the Cocoa, after drying, were sorted in a Pernollet machine. The broken nibs and small beans appeared to find a ready sale locally. One planter had his large beans picked over again by hand, which, he said cost 2½d. per bag. When we were at San Antonio some coolie women were picking Cocoa over in the floor of a shed.

Manuring.—There seemed to be practically no manuring on the Cocoa plantations whatever; pen manure that a Cocoa planter had, he put on his estate, but this was necessarily small as few animals are kept. We did not hear anywhere of artificial manures being successfully applied. All the husks after breaking the Cocoa, and the branches of the trees were left upon the ground to rot, but apart from this nothing was put upon the lands. Some of the planters said they had tried artificial manures without success but all testified to the value of pen manure when they could get it.

Pruning.—Most of the planters cut away all the suckers, leaving the stem some four or five high before they allowed it to branch, and their idea in pruning, seemed to be, to keep the tree evenly balanced upon this central stem.

One planter who had original ideas on pruning sometimes allowed suckers to grow on a tree. His main idea being to keep the tree evenly balanced and to prevent any part of the stem being exposed to the wind or rain.

Drainage.—On the flat estates there is the expense of drainage. These have to be made when forming the estate and to be kept clean afterwards.

Pests.—These are mainly squirrels and rats. They make holes in the pods, and eat perhaps one or two beans only, then leaving them, but the rain is admitted and the Cocoa is turned black and rotten. Ten cents. a tail is paid for these animals. Some birds also make holes in the pods to attract insects. The old trees on many damp estates are covered with moss which has to be scraped off from time to time. We noticed this particularly on one estate, where the manager told us they paid 2s. a tree, using a corn cob for the purpose.

Another pest is the Cocoa Beetle which is systematically hunted for and destroyed whenever there are evidences of its appearance.

The Crop of an Estate depends on

1st. There being an average amount of rain whilst the trees are flowering and the pods are young, as a continued drought then withers up the young pods.

2nd. A not too continuous rain on the other hand when the pods are ripening as this makes them turn rotten.

Time of Crop.—The picking goes on during the whole of the year, the main crop however begins in October and November, and the "sweat" boxes were nearly always full from January to March. A smaller crop again takes place in June or July.

Age of Trees.—The trees on one estate were 32 years old and were in good bearing condition, but there were trees on some of the older estates in the Island, between 90 and 100 years old. It seemed to be generally considered that the trees properly looked after should yield well for 50 or 60 years at least.

Yield of Trees.—One estate yielded two or three lbs. per tree, and one tree situated near a stable yielded 32 lbs, of Cocoa. A planter showed us a tree from which he had picked 300 pods or 22 lbs., in one year. The present yield on one estate was 14 bags of 185 lbs., per 1,000 trees.

Size of Estates.—These vary, from the negro who had a few trees to the large estate of 100,000 trees. One Estate had 90,000 trees. Another had 70,000 trees, and another estate 60,000 trees One of the largest in the Island, had a yield of 1,500 bags. For the greater proportion of the Cocoa in Trinidad appears to be grown on large estates.

Price and Value of Estates.—One planter considered that an estate would not pay if it did not contain 10,000 trees.

Another thought at present prices, an unencumbered estate might yield 15o/o net profit, all expenses of management paid, but that 10o/o was a more likely figure.

Cost of production of Cocoa.—A planter told us he considered that it did not pay to grow Cocoa that was selling at 45s. per cwt., or at any rate he did not consider it worth while to plant Cocoa at this price. At the present prices a new estate did not begin to pay until 12 to 14 years, and then only yielded 8 per cent. interest after paying a mortgage charge of 8 per cent., which seemed to be the general rate. Another said that Cocoa could be grown at 21s. a cwt., and mentioned that he had a small estate which was managed by his wife, on which it only cost him four dollars a cwt. Another said it could not be grown under eight dollars a cwt, and that he did it at this price. Labour had been cut down to 25 to 30 cents, instead of 30 to 50 cents a day, which used to be paid. The cost of production of Cocoa depends largely upon the position of the estate, as some estates had to pay as much as a dollar a bag to get the Cocoa down to Port of Spain, being a long way from either road or railway. Planters said they would be quite content if Cocoa rose 5s. a cwt. above the then ruling low prices, (45s.)

Shipping Cocoa.—All the Cocoa is shipped to Europe or America as soon as it is dried, as it will not keep in the moist, tropical climate of Trinidad.

Increase in Production.—This seemed to be going on on all hands, although the drop in prices had slightly checked it. The increase is put down at between 5 and 6 per cent. per annum. A new railway will shortly be completed across the island, which will open up a large, fertile district, where there are several important plantations in process of formation.

Statistics of Cocoa Cultivation.

(Sugar Commission Report. Vol. II. Appendix 282.)

Estate.	1. Total Acreage.	1. Average Crop per annum.	2. Cost of production per bag.	6. No. of Indentured Immigrants employed.	6. No. of Free-Residents employed. East Indian.	Creole.	6. Outside labour employed.
	Acres.	Bags—165lbs.	£ s. d.				
Talparo ...	394	650	1 11 6	...	8	19	6
Mount Pleasant ...	227	100	2 15 0	...	14	...	5
Montserrat ...	300	572	1 17 6	...	8	4	*
San Leon Grande San Louis	935	600†	1 13 4	...	10	20	20
La Compensacion San Jose	571	1,237	1 12 0	...	33	16	14
Mararaval La Carmelita	311	949	1 6 0	38	16	...	*
Esmeralda ...	550	464	3 15 0	15	19	34	100
Adivinanza La Gloria	520	350†	*	*	*	*	*
Esperanza ...	744	349	2 1 8	...	30	*	*
La Descada La Regalada San Rafael	600	940	2 1 8	...	6	0	80
San Carlos ...	564	300	1 17 6	...	30	3	25
Tierra Nueva Caurita	766	900	1 13 4	...	*	*	42
Torrecilla ...	849	400	1 13 4	...	2	4	*
Ortinola ...	430	520	3 18 10	...	...	...	*
Santa Estella ...	649	807	1 15 0	...	38	23	...
San Francique ...	200	150	3 0 0	16	...	...	*
El Salvador ...	357	1,500	2 5 0	80	2	0	80

Venezuela.

General Remarks on the Cultivation of Cocoa in Venezuela.

The Cocoa in Venezuela is cultivated on a narrow strip of land along the northern coast. The interior of the country is high table-land, too high for the Cocoa to flourish. A small quantity is grown in the valley of the Orinoco, but, with this exception, and also that of Orinoco, where Cocoa is grown, the whole of the Venezuelan Cocoa is grown on a narrow strip of land, within 20 miles of the sea. The main producing districts are the districts round Rio Chico and the Puerto Cabello—the peninsula of Paria. On the peninsula of Paria, the the Carupano, Guaira and Yrapa Cocoas are grown. After Carupano

* No returns. † Young cultivations.

there is a little stretch of coast where Cocoa does not flourish, until we come to Carenaro, in which neighbourhood, the Rio Chico and Iguerote are grown. All the best Caracas Cocoa comes from the country, west of La Guaira—in fact, the further west you go, the better the Cocoa becomes : the best of all coming from the two adjacent valleys, in which the town of Ocumare and Choroni are situated, the Chuao estate being situated in the latter valley. Each valley appears to have a slightly different growth of Cocoa.

Varieties of Cocoa Grown.—The two varieties of Cocoa grown in Venezuela are, the Criollo and the Forastero, the Forastero Cocoa being planted and grown on the Paria peninsula and probably in the neighbourhood of Rio Chico, whilst the true Criollo Cocoa is grown in the Ocumare and Choroni valleys, and in the neighbourhood of Porto Cabello. Probably some of the commoner kinds of Porto Cabello Cocoa come from the Forastero variety of tree, which has been planted in the neighbourhood.

The value of the Cocoa.—The value of the Caracas depends upon the variety of the tree from which the beans are gathered, and the quality of the soil upon which the Cocoa is grown. There appears to be no doubt whatever, that the very best kinds of Caracas Cocoa can only be grown on the best soils, and the best soils which have been found hitherto have been those of the Ocumare and Choroni valleys.

Arrangement of an Estate.–The estates we saw were arranged exactly as in Trinidad, the trees being planted about 12 or 15 feet apart, in rows and shaded by the Immortelles.

Kind of Soil.—The soil around Porto Cabello, we noticed, was of a rich red colour. The sand which was used to cover the Cocoa at Ocumare comes from the Choroni Valley, from whence they get it on account of its red colour.

Work on an Estate.—Appeared to be the same as in Trinidad. The labourers employed, were the native peons. There seemed to be very few negroes in Venezuela, the bulk of the labourers being peons with Spanish blood in their veins.

Wages.—One man told us, at Ocumare, that he paid 90 cents for having 6 fanegas of Cocoa gathered and cured. We did not learn what the rate of wages were, but were told that they were high as labour is scarce.

Gathering Cocoa.—The same as in Trinidad.

Breaking Cocoa.—The same as in Trinidad, except, at Ocumare, we noticed they cut open the pods lengthwise, instead of across, as in Trinidad.

Sweat Beans.—Those on some estates had been made on the Trinidad model with cement. Elsewhere the Cocoa seemed to be thrown into a wooden box upon banana leaves, the box being placed in some outhouse.

Fermentation.—The owner of one estate said, he fermented one day only. Another said he fermented his Cocoa three or four days.

Drying Cocoa.—The old method of drying Cocoa in Venezuela is to spread the beans out in a large, open, courtyard paved with tiles. These courtyards are placed in front of the hacienda and have a low wall running round the three sides. They slope towards the centre, where there is a drain. If the weather be wet, the Cocoa has to be

gathered up and taken inside, as there is no roof to put over it in case of rain, as in Trinidad. Just before the Cocoa is dry, it is rubbed over with red sand, which has been previously sifted. It is thought the sand helped to keep out insects. It also possibly hardens the shell and prevents breakage, and, of course, it also gives the Cocoa a more even, and better appearance. All the Venezuela Cocoa is dried again at the port before shipment. It takes three or four days to dry on the hacienda. At Carupano in the courtyard behind a planter's house, were a great many large wooden trays in which the Cocoa was spread, exposed to the sun. These trays were made to run on lines, and were pushed under sheds, which were ranged round the courtyard, at night time, and when it rained. At La Guaira, Cocoa was drying upon the roof of a warehouse. This seemed to be the method adopted there

Picking and Storing.—This was done by means of a Pernollet machine on one estate at Ocumare, but probably this was an exception.

Draining.—This was well looked after at Ocumare, all the estates we saw, being drained.

Time of Crop.—Corresponds with the Trinidad crop.

Yield of Trees.—We were told by the owner of an estate at Ocumare, that the trees yield from one to two pounds each, and again, we were told that they averaged one pound each.

Size of Estates.—A planter had amalgamated nine or ten estates at Ocumare, and had an output of 2,500 bags of 110 lbs. each. There were some four or five more estates in the valley.

Value of Estates.—The 9 or 10 estates mentioned above had cost £80,000.

Cost of Production. This was difficult to get at, but in talking to a planter at Ocumare, we mentioned that they had told us in Trinidad that the cost was 8 dollars per cwt. This price, he said, struck him as excessive.

Shipping Cocoa.—All the cocoa grown on the Paria peninsula is now shipped from Carupano, whilst La Guaira only sends that grown round Rio Chico, and in the Valleys to the west of La Guaira. This does not include Maracaibo which ships direct.

Increase in the Production of Cocoa.—The production of Cocoa in Venezuela was not extending. The district around Porto Cabello produces about 7,000 bags and the best valley appeared to be well planted up, so that there is not much possible room for extension.

General Remarks.—The system of cultivation and preparation in Venezuela is said to be very crude, and there was a great lack of system. There is no increase in production going on in the common kinds of Cocoa, though there is plenty of land for this, owing to the lack of energy on the part of the people. There did not appear to be any reliable statistics on the production of Cocoa.

The price of common Cocoa depends upon the price ruling, in other kinds, upon the European markets, whilst the price for the better kinds which cannot be got elsewhere, depends upon the quality produced in the one or two valleys where it is grown.

Grenada.

General Remarks on the Cultivation.—The Island of Grenada used to have a large export of sugar, this has, however, been entirely given up and the old sugar lands have been largely planted with Cocoa. The Cocoa has also replaced the original forests on many of the hill-sides of Grenada.

The Island is very hilly throughout, the mountains rising direct from the sea. Communication is difficult as the roads have not been kept up, and there are only bridle paths across the Island.

Varieties of Cocoa grown.—The trees are probably a cross between Calabacillo and Forastero, although the Forastero is largely predominating

The value of the Cocoa.—Our planter considered that this depended entirely on the sweating. Another said that the difference between Grenada and Trinidad Cocoa depended upon the soil and the kind of Cocoa used.

Formation of an Estate.—The Estates in Grenada, as in Trinidad, have been formed mainly by contractors. At the current price of Grenada Cocoa we were told that a new Estate ought to pay in five or six years after planting.

Arrangement of an Estate.—The trees are planted as in Trinidad some ten or twelve feet apart, except that no shade trees are used.

This is due to the hilly nature of the country, as the Cocoa trees are planted on the shady side of the valleys. The Cocoa trees, however, do not look so well as they do in Trinidad, the tips of the leaves are often shrivelled and brown with the sun. The trees are planted slightly closer together than in Trinidad, and are not so tall. The general impression left upon us was, that the cultivation was not so good as in Trinidad.

Kind of Soil.—A great many of the plantations in Grenada are upon old, abandoned sugar estates, owing to the fact of all the land being under cultivation. The Cocoa in the valleys gives a better return than that upon the hill-sides.

Work on an Estate.—Very much the same as in Trinidad, except, as stated above not so much care is taken over the cultivation. We were told that no weeding was required. Labour employed is nearly all negro, as there are very few coolies in Grenada, they have not had any immigrants for some time past.

Gathering Cocoa and breaking Cocoa.—These operations are done in the same manner as in Trinidad.

Sweat Boxes.—These are the same as in Trinidad, only, they are not so well made. Those on one estate were inside an old sugar-boiling house, about 5 feet square each. There was a row of them, arranged along the wall side.

Fermentation.—The best Cocoa in Genada is fermented from seven to nine days, (the common Cocoa only three days) and turned over several times during the process.

Drying Cocoa.—The Boucans, as the drying sheds are called in Grenada, are somewhat differently arranged to those in Trinidad, inasmuch as they have a set of drawers that run in on iron rails, underneath the drying shed itself. There are generally two sets of these drawers,

one below the other, which pull out on either side of the drying floor, thus one roof is able to protect nearly three times the drying area that a similar roof will do in Trinidad. It appeared to be a more economical and a better thought out system than that in use in Trinidad.

The Boucan is often placed near a little village on the coast from whence the Cocoa is shipped, thus being able to serve two or three estates. The Boucan at Gouava dried the Cocoa from three estates. Best Grenada Cocoa, is "danced" just before shipping. On one estate, we were informed, they used an artificial dryer. On another estate the manager had recently constructed one, on the principle of one they had in Ceylon.* The principle upon which it worked consisted in drawing hot air from a stove, over the Cocoa, which was spread out in trays in a small wooden house. He used a small Blackman Fan. He said this had been very successful, and had saved him a considerable quantity of Cocoa, and many of his neighbours had wanted to dry their Cocoa in his dryer. When dried in the air, it took three or four days, depending, of course, on the weather.

Picking and Sorting.—We did not see any evidence of this being carried out in Grenada.

Manuring.—There appeared to be no manure applied other than the small amount of stable manure that the estate happened to possess. One planter, however, collected as much as he could from the town of St. George's, his estate being a little way off, and he obtained his very high yield of Cocoa from the high manuring which he practised.

Pruning.—It was said this should be done every three or four years.

Time of Crop.—This is the same as in Trinidad.

Yield of Trees.—One planter said that he obtained five bags per acre of 500 trees. Another considered that an average yield would be four or five bags per acre.

Another said that four bags per acre was an average yield; although this might be increased by manuring, the truth of which was illustrated by the fact, that one owner obtained eight bags per acre on his small estate.

Value of Estates.—A planter said, at the price then current, an unencumbered estate paid, in Grenada, but it did not pay to plant a new estate. He put the cost of Cocoa in Grenada without reckoning interest and managing expenses at 20s. to 25s. per bag of 125 lbs. He said, an estate purchased at £40 or £50 per acre ought to pay a clear 15 per cent. Another said it still pays to plant Cocoa in the valleys, and an estate ought to yield 10 to 15 per cent. after the managing expenses had been paid.

Increase of production of Cocoa in Grenada. Estates are still being added to, by further planting, but no new ones are being formed. According to one planter, the Island was capable of doubling its production of Cocoa. Another said that the increase in the next few years might be 1,000 bags a year. This was not as great as it might be, owing to the fact that some of the hill cultivation was being allowed to deteriorate, as this did not pay.

---

* For description of this drying house, see *Bulletin*, Old Series, Nos. 41 and 48.

RUBBER.

The following letter has been communicated by the Secretary of State for the Colonies :—

The Director of Royal Gardens, Kew, to Colonial Office.

Royal Gardens, Kew, December 20th, 1897.

Sir,

I have the honour to acknowledge the receipt of your letter of November 30th, enclosing for observations Ceylon Sessional Paper XXIII of 1897 on the cultivation of Rubber-producing trees.

2. It appears from this that a number approaching a quarter of a million rubber-trees of various ages are under cultivation on private estates in Ceylon. This represents an area of about 750 acres. In addition 85 acres have been planted by the Conservator of Forests.

3. Data are still wanting as to whether the enterprise will be sufficiently profitable. Rubber-planting appears to require from 8 to 11 years before it yields any return. It is therefore obviously unsuited to small proprietors. On the other hand, if it pays at all, it may well receive some attention on large estates and at the hands of a Government Forest Department.

4. The actual amount of land in most of our tropical Colonies suitable for Para Rubber is probably not large. As suggested in my letter of September 6th it is likely to be most successful in the Straits Settlement. Through the instrumentality of Kew the Para Rubber tree was introduced into Perak. Sir Hugh Low reported in 1879 :— "They take to the country immensely." It is understood that these trees have been successfully tapped. It would be extremely useful to have an official report upon the present result of Sir Hugh Low's experiment.

5. Dr. Morris is of opinion that in the West Indies "where banana cultivation can be carried on rubber trees might afford a useful subsidiary crop." It has been estimated that trees planted 10 feet apart at 11 years would yield 6 oz. of rubber. This would give a gross return of £22 10s. 0d. per acre. For this purpose Castilloa would be perhaps more suitable than the Para Rubber tree.*

I am, &c.,

W. T. Thistleton-Dyer.

C. P. Lucas, Esq.,
Colonial Office, Downing Street, S.W.

NOTE ON CEARA RUBBER.

By S. T. Scharschmidt, A.M.I.C.E.

In the Bulletin for October and November, 1897, I observe the article on "Ceara Rubber." In May, 1887, I put in 6 plants which I got from your Department at Hanbury; the largest is now 25 feet high and 10 inches girth at 4 feet from the ground. It is only this year, and in this month December, that I find the rubber begins to assume

* For information on Rubber, consult *Bulletin* 1894 (page 99), 1895 (page 31), 1897 (pages 80, 242).

fairly good properties. The rubber was collected in the following manner :—The epidermis was taken off the bark so as to give a clean smooth surface. The bark was then scarred with a sharp knife somewhat spirally, the incisions being about $2\frac{1}{2}$ inches apart. The milk exuded rapidly, and after allowing it to rest till bleeding ceased, that is for about 5 minutes, I rubbed the open hands up and down and round about the surface of the bark under treatment. The milk readily adhered to the hands, and coagulated rapidly. I send you a small sample of the rubber so obtained. There is a good crop of seeds now on the trees. Hanbury is 1,550 feet above sea level ; the average annual rainfall is 99 inches.

WAX PALMS OF THE ANDES.

CEROXYLON ANDICOLUM, Humb. & Bonpl.

Ceroxylon andicolum, the Wax Palm of the Andes, was first made known and described, says the *Treasury of Botany*, by the celebrated travellers Humboldt and Bonpland, who found it growing in great abundance in very elevated regions on the chain of mountains separating the courses of the rivers Magdalena and Cauca, in New Grenada, extending almost as high as the lower limit of perpetual snow, which is a remarkable fact when it is remembered that the generality of the palm tribe luxuriate in tropical climates. It has a straight trunk of great height, and about a foot in diameter, cylindrical for the first half of its height, after which it swells out, but again contracts to its original dimension at the summit ; but the most singular feature connected with the trunk is the circumstance of its being covered with a thin coating of a whitish waxy substance which gives it a curious marble-like appearance It is surmounted by a tuft consisting of from six to eight handsome pinnate leaves, each of which is about twenty feet long, and has a strong thick footstalk, the base of which spreads out and clasps round the trunk, leaving a circular scar when it falls away ; the leaflets are densely covered on the under side with a beautiful silvery scurf, while the upper side is of a deep green colour. The waxy substance of the trunk forms an article of commerce amongst the inhabitants of New Grenada. It is obtained by cutting down the tree and scraping it with a blunt implement, each tree yielding about twenty-five pounds. According to the analysis of Vauquelin, it consists of two parts of resin and one of wax, and is therefore of too inflammable a nature to be used by itself ; but by mixing it with one-third part of tallow, very good candles for ordinary purposes are manufactured from it. The candles used by the inhabitants for offerings to the Saints and Virgin are, however, made without any such mixture ; but on account of their resinous nature the priests will not allow them to be used for the high ceremonies of the Romish Church. The wood is very hard towards the exterior, and is commonly employed for building purposes ; and the leaves are used for thatching.

The following interesting letter has lately been received by the Director from Mr. Robert B. White from Cauca, in Colombia :—

I forwarded you by sample post a few seeds of what I believe to be an interesting variety of Ceroxylon andicolum. This palm as you know is found in the Central Andes. Its inferior limit is 7,000 feet with a mean temp. of 60° but it is most abundant at 8,000 to 9,000 feet with a temp. of 55° to 57°. The palm I send you is found in the Western Andes, 60 miles South of Cali, in the Valley of Cajamarca on the Pacific watershed. It is most abundant at 5,500 feet in a mean temp. of 61 to 68°. Good sugar cane grows alongside of it. The flowers, fruit, etc., are similar to those of andicolum but the tree is very distinct. It has no base of fasciculated rootlets, as andicolum has, but springs clear from the ground. The stem is slighter, not so tall as andicolum and I should say that 150 feet is the average. The leaves are 20—25 feet long but much slighter and lighter than andicolum and there is much less silvery scurf on the under side of the pinnæ. These, whilst the leaf is not fully grown and hardened, are joined together at the points by a slender thread like some Attaleas and Sabal and I have not noticed this peculiarity in andicolum. The wax which coats the stem is as abundant as in andicolum, but seems to be different in composition. It has an agreeable smell when rubbed or when burned, which the wax of andicolum has not, and it is more brittle, which would seem to indicate a larger proportion of resin. At Kew this will be investigated, and I only send you a small sample for you to see what it is like. If you would like more, I shall have pleasure in sending you some.

This palm is evidently more easy to acclimatize than andicolum and it may be of yet greater value if the wax turns out to have other properties.

I should mention that the farinaceous pulp within the rind covering the seeds is slightly bitter, and appears to be more abundant than in andicolum. Pigs however eat the whole fruit with the same relish as they do that of andicolum and it fattens them famously.

The palms here flower twice in the year, but supposing that they only flower once, they will bear about 16 arrobas (400 lbs.) of fruit. When maize is worth 20 cents. the arroba, or 80 cents. per 100 lbs., the annual value of a wax palm for fattening hogs is $3.20. The palms may be climbed just as they climb cocoanuts, and the wax scraped off. Here they cut down the palms, and each one yields from 15 to 25 lbs of wax.

Tallow candles made with a mixture of 10 per cent. of this wax give a good light, and are as hard as ordinary wax candles, but the wax of andicolum gives a disagreeable smell to the smoke, which will not be the case of the wax of the Cajamarca variety is employed.

I think it is likely that the prehistoric aborigines may have acclimatized the original palm in the Western Cordillera, and that it may be fairly named *Ceroxylon andicolum* var. *occidentale.*

OKA OF PERU.

OXALIS CRENATA, Jacq.

Kew Gardens to Public Gardens, Jamaica.

Dear Sir,

I am sending you a few tubers of *Oxalis crenata*, the "Oka" of the Peruvians, which is worth a trial as a vegetable for table. The tubers should be planted like the potato. New tubers are formed at the end of the season and under favourable conditions they are 3 inches long and weigh 2 ounces. When lifted, they should be exposed to sunlight for two or three days. To cook them boil for 20 minutes in water containing a pinch of carbonate of soda; they change to a bright amber colour, and if eaten with pepper and salt they are palatable and of pleasant flavour.

Yours faithfully,

W. T. THISTLETON-DYER.

The *Treasury of Botany* states that it is largely cultivated about Lima for its very acid leafstalks.

The following seeds have also been received from Kew:—

Heterospathe elata, Scheff (a palm from Amboina).

Pitcairnia ferruginea, Ruiz & Pav., one of the Bromeliaceæ or wild Pines. The flowering scape is 5 or 6 feet long, and flowers 5 inches long, greenish-white. It is a native of Peru.

COCCIDÆ, OR SCALE INSECTS.—XII.

By T. D. A. COCKERELL, Entomologist of the New Mexico Agricultural Experiment Station.

Genus *Aspidiotus*. (Continued).

(75.) *Aspidiotus articulatus*.—Morgan. (The West Indian Red Scale).

Diagnosis.—A small flat scale, about the size of a pin's head, deep orange in the middle and whitish round the sides, circular in outline. On lifting up the scale with the point of a pin or knife, the orange-coloured insect is seen beneath, and with a hand lens it is easily observed to be deeply constricted between the thorax and the abdomen.

Distribution.—Very abundant in Jamaica. Also found in Nevis. Barbados, Demerara, Trinidad, Mexico, and Lagos, W. Africa, It is quite possible that it is really a native of Africa, which has been introduced into the West Indies. Maskell has described a variety (*A articulatus* var. *celastri*) from the Cape of Good Hope.

Food-plants.—It is abundant on palms, but also infects many other plants, including grape-vine, lime, orange, *Pancratium* (or *Hymenocallis*) *caribaeum*, lignum-vitæ, olive, *Tabernæmontana coronaria*, violet, rose, star-apple, guava, *Lawsonia alba*, pomegranate, *Anacardium occidentale*, mango, akee, genip, *Apeiba*, *Hibiscus*, *Bignonia magnifica*, *Persea*, &c.

Destructiveness.—This is a decidedly pernicious species, especially on palms and *citrus* trees. It is not yet universally distributed in the West Indies, and care should be taken to prevent its introduction into new localities.

(76). *Aspidiotus aurantii* Maskell.—(The Californian Red Scale).

Diagnosis.—The scale closely resembles the last, but there is a sort of nipple-like prominence in the middle, and the insect itself does not show the deep constriction between the thorax and abdomen.

Distribution.—Jamaica, Montserrat, California, Arizona, Australia, Hong Kong, Formosa, Japan, New Zealand, Fiji Is., Sandwich Is. Samoa, Tonga, New Caledonia, Central America, Cuba, Ceylon, the Mediterranean Region, and, if I remember right, Lounsbury reports it from South Africa.

Food-plants.—Usually this species is known as a destructive pest of *Citrus* trees, but as found in Jamaica, it never attacks *Citrus*, but occurs on lignum-vitæ principally. *A. articulatus*, which is *very rarely* found on lignum-vitæ, takes its place on *Citrus*. Other food-plants of *A aurantii* are *Podocarpus* (in Japan), coconut palm (in Central America), *Taxus* (in Italy), *Agave Americana* (in Ceylon), rose, grape, &c., (in California).

Variety.—A brownish-yellow variety has been named *citrinus* by Coquillett. It occurs in California and Japan.

Enemies.—This scale has many natural enemies. In Australia it is attacked by a fungus, *Microcera coccophila*; which fungus, it may be remarked, also occurs in Jamaica, infesting *A. articulatus.* Mr. Koebele reports that several coccinallid beetles (*Orcus chalybeus, O. australasiæ, Rhizobius satellus*) prey upon *A. aurantii* in Australia. Dr. L. O. Howard reports six hymenopterous parasites from California, of which three (*Coccophagus lunulatus*, How., *Aphelinus diaspidis*, How., and *Aphycus immaculatus* How., infest typical *aurantii*; and three others (*Aspidiotiphagus citrinus*, Craw., *Prospalta aurantii*; How., and *Signiphora occidentalis* How.,) the var. *citrinus.*

Destructiveness.—When it occurs on *Citrus* trees, as in California and the eastern Mediterranean region, it is a first-class pest. In Jamaica it is not found in quantity, even on lignum-vitæ, and is of no economic importance. It is probable that if the *Citrus*-feeding form were introduced into the West Indies, it would be destructive as elsewhere.

(77). *Aspidiotus ficus*, Ashmead. (The Red-spotted Scale).

Diagnosis.—A small circular black or dark brown scale, with a central shining reddish or orange boss.

Distribution.—Common in Jamaica. Also found in Cuba, Hayti, Florida, Mexico, Australia, Ceylon, Japan, Egypt, Formosa, and in hothouses in various parts of the United States and Europe. It seems not yet to occur in the lesser Antilles.

Food-plants.—Very various, including *Ficus* spp, *Citrus* trees, *Laurus virginiana*, coconut palm, *Oredoxa regia*, *Curcuma longa* *Pandanus*, *Cœlogyne cristata*, jambolana, *Myrtus Hillii*, *Castaneosper-*

mum, camphor laurel, *Atlanta buxifolia*, rose, *Machilus Thunbergii Quercus cuspidata*, *Garcinia Cambogia*, *Rhododendron arboreum*, guava, *Lonchocarpus Barteri*, &c.

Enemies.—The parasite *Aspidiophagus citrinus* has been bred from it by Prof. W. G. Johnson.

Destructiveness.—When abundant it may become troublesome, but it occurs scattered over the leaves and twigs, not massed like *A. articulatus*. It is, on the other hand, a much more conspicuous scale than *articulatus*.

(78.) *Aspidiotus destructor*, Signoret. (The Bourbon Aspidiotus.)

Diagnosis.—A very thin, flat, circular white or whitish scale, with a very pale yellow central spot.

Distribution.—Abundant in Jamaica and Trinidad. Also found in Grenada, Barbados, Antigua, Porto Rico, Demerara, Bourbon, Marquesas Is., Laccadive Is., and Formosa.

Food-plants.—Various palms, *Bassia latifolia*, guava, banana, mango, *Terminalia Catappa*, *Pandanus*, &c.

Distructiveness.—Its name was given on account of its destructive propensities in Bourbon. More recently it has been complained of as a serious pest in the Marquesas Is., and it is quite troublesome in Trinidad. It is undoubtedly a native of the tropics of the old world.

(79.) *Aspidiotus hederæ*, Vallot, var. *nerii*, Bouché.—(The Oleander Aspidiotus.)

Diagnosis.—Like *destructor*, but whiter, with the central spot smaller and of a pale orange tint.

Distribution.—In the West Indies known only from Grenada. It is a very common scale in the Mediterranean region and other parts of Europe, as well as in the United States. It is also found in Chile and Mexico. While *A. destructor* is essentially a tropical insect, *nerii* belongs to the warmer parts of the temperate zone, and is rarely observed in the tropics. Maskell reports it from New Zealand, Australia and the Sandwich Is.

Food-plants.—Very numerous. In Grenada it was found on olive, elsewhere it occurs on *Melia*, currant, ivy, *Acacia*, cherry, lemon, maple, *Yucca*, plum, lilac, arbor-vitæ, *Agave americana*, *Magnolia grandiflora*, *Quercus agrifolia*, *Arbutus Menziesii*, *Solanum Douglasii*, *Aristea major*, *Clematis flammula*, *Spartium junceum*, *Calycotome spinosa*, *Ceratonia*, *Robinia pseudacacia*, *Cratægus*, *Phillyrea media*, *Antirrhinum majus*, *Stachys circinata*, *Laurus nobilis*, *Smilax aspera*, &c.

Varieties.—The species is commonly known as *A. nerii*, but it is only the more frequent form of the ivy scale, earlier named *hederæ*. The form on lemons is known as var. *limonii*, Signoret; a form found on *Ceratonia* is var. *ceratoniæ*, Signoret; a form on olive is var. *villosus* Targ. Tozz.

Enemies.—The Rev. A. E. Eaton writes that in Algeria it is preyed upon by *Chrysopa vulgaris* and Coccinellidæ. Berlese has reared *Prospalta aurantii*, Howard, from the *hederæ* form in Italy.

Destructiveness.—It is a troublesome pest where it abounds, but it is much too rare in the West Indies to be of economic importance.

(80.) *Aspidiotus personatus*, Comstock. (The Masked Aspidiotus.)

Diagnosis.—A very small, convex, dark grey or black scale, looking like some fungus,—especially the date-palm fungus, *Graphiola phoenicis.*

Distribution.—Jamaica, Antigua, Cuba, Barbados, and Acapulco, Mexico. Also in Kew Gardens, under glass.

Food-plants.—*Areca rubra*, *Sabal*, cocoa-nut palm, star-apple, rose, guava, and a variety of other plants.

Destructiveness.—Not usually very troublesome, but I have seen it abundant enough on the leaves of the olive to do serious injury.

(81.) *Aspidiotus dictyospermi*, Morgan. (The Dictyospermum Aspidiotus.)

Diagnosis.—A small flat greyish or reddish scale, very much like *A. aurantii.* The insect is known, under the microscope, by the pair of long serrated processes on each side of the hind legs.

Distribution.—Demerara (typical form and var. *arecæ*), Jamaica (var. *jamaicensis*), Hong Kong (a slight variety), Ceylon (collected by Mr. E. E. Green), Trinidad (colleeted by Mr. J. H. Hart), and occasionally in hothouses in the United States.

Food-plants.—*Areca catechu*, *Dictyospermum album*, *Erythrina indica*, &c. The var. *jamaicensis* on *Cycas* and rose.

Varieties.—It appears to be quite a variable species. The var. *arecæ*, Newstead, is from Demerara; var. *jamaicensis*, Ckll., occurs in Jamaica. *Aspidiotus minor*, Berlese, on *Pandanus* in cultivation in Italy, is apparently a form of the species. *A. mangiferæ*, Ckll., found on leaves of mango in Kingston, Jamaica, is perhaps a distinct species, but I decidedly incline to the opinion that it is but a variety of *dictyospermi.* A description of it may be found in Journ. Inst. Jamaica, vol. 1, p. 255.

(82.) *Aspidiotus rapax*, Comstock. (The Greedy Aspidiotus.)

Diagnosis.—A small, convex yellowish-grey scale, with a dark brown or black spot somewhat to one side. The scales commonly occur along the sides of the midrib of leaves.

Distribution.—Jamaica, not frequent. Also in Antigua, Ceylon. Amoy (China), New Zealand, and the southern part of Europe and the United States. The Rev. A. E. Eaton found it in Algeria, and Dr. Grabham sent me specimens from Madeira.

Food-plants.—Very various; *Casuarina*, *Stillingia sebifera*, *Euonymus japonicus*, *Cercis siliquastrum*, myrtle, *Fuchsia*, *Pittosporum*, guava, *Camellia*, olive, almond, quince, fig, willow, *Eucalyptus*, *Acacia*, &c., &c.

Destructiveness.——It is a destructive insect, but not common enough in the West Indies to do any appreciable damage. Mr. Green says it is a rather serious pest on tea in Ceylon, and he has seen a young *Cinchona* killed by it.

Note.—This insect is frequently called *Aspidiotus camelliæ,* a name which was applied to it in error by Signoret.

(83). *Aspidiotus punicæ,* Ckll. (The pomegranate Aspidiotus).

Diagnosis.—A small white scale, with a small shining orange-brown boss. The scale is rather like *rapax,* but not so convex, and of a different colour.

Distribution.—Jamaica, Dominica, Brazil, and in a hothouse in Washington, U.S.A.

Food-plants.—Originally found on pomegranate, but more frequently observed on palms.

Destructiveness.—It would be destructive if abundant.

(84.) *Aspidiotus diffinis.*—Newstead var. *lateralis,* Ckll.

This a scale found on *Jasminum* in Jamaica, which may prove to be only a variety of *punicæ.* The scale is convex, brownish-white to brown. The typical *diffinis* is from Demerara.

(85). *Aspidiotus bowreyi,* Ckll. (Bowrey's Aspidiotus).

Diagnosis—Small elongate gray scales, with a blackish spot towards one end.

Distribution.—Only known from Hope, Jamaica, where it was discovered by Mr. Bowrey.

Food-plant.—*Agave rigida.*

Destructiveness.—The scales occur crowded on the plant, and must be harmful.

This ends the series of West Indian Coccidæ, except a few species discovered since the genera they belong to were discussed, which will be described in a supplementary article.

FERNS: SYNOPTICAL LIST—L.

Synoptical List, with descriptions, of the Ferns and Fern-Allies of Jamaica. By G. S. JENMAN, *Superintendent Botanical Garden, Demerara.*

7. *Acrostichum chartaceum,* Baker.—Root-stock shortly repent or erect, freely clothed with bright dark-brown or castaneous paleæ; stipites tufted or sub tufted, erect, 2–6 in. l. bearing at first a few scattered brown scales; fronds linear-lanceolate, acuminate, much tapered at the base, $\frac{1}{2}$-$1\frac{1}{4}$ ft. l. 1-2 in. w., chartaceous or sub-coriaceous, naked or sprinkled with minute punctiform brown scales over the paler under surface, the upper a glossy dark, rather metallic green; rachis distinct on both sides, slightly channelled above; veins usually evident on the surface, 1–3 times dichotomously forked, $\frac{3}{4}$–1 li. apart; fertile fronds narrower, as long or not, sometimes longer, on stipites of equal length with those of the barren or longer.—Journ. Bot. 1882, p 327.

Very plentiful in forests at 5000–6000 ft. alt. on decaying logs and other substance on the ground. This was first ascribed to *A. Sartorii,* Lieb. from which it appears to be distinct. In shape of frond it resembles *A. flaccidum,* Fée, with which Jamaica specimens have before

been placed, but its larger size, much longer petioles and dark nearly metallic green colour and different habit quite distinguish it. The much tapered sides of the fronds often somewhat expand at the very base. Near the margin the veins occasionally and casually unite. From *latifolium* it differs in texture, colour and shape.

8. *A pallidum,* Baker.—Root-stock woody, very stout, cylindrical, elongated, densely clothed with loose, undulated, narrow, glossy, dark-coloured scales $\frac{1}{4}$–$\frac{1}{2}$ in. l.; stipites numerous, cæspitose, rather slender, 5–10 in. l., scaly at the base; fronds pendent or spreading, oblong-lanceolate, $\frac{1}{2}$–$1\frac{1}{4}$ ft. l. $1\frac{1}{4}$–$2\frac{1}{2}$ in. w. the apex acuminate, the base rounded, or in the smaller states cuneate; coriaceous, but pellucid, naked, pale green, the margins repand, cartilaginous-edged; veins forked, $\frac{1}{2}$–1 li. apart, the bases dark-coloured; fertile fronds smaller, the same shape, on rather longer stipites.—Journ. Bot., 1879, p. 263.

Abundant on open banks near the Government Cinchona Plantation at 5000 ft. alt. The rootstock is an inch thick, increasing in diameter as it elongates, erect or oblique (not at all repent) and densely clothed with linear crispate or undulate almost blackish scales, with the fronds cæspitose at the apex. The fronds are as many as 1–2 dozen to a plant, though fewer also in numerous instances. The largest ones are sub-cordate at the base. The colour is unusually pale.

9. ***A.*** ***conforme,*** Swartz.—Root-stock short-creeping, rather woody, densely clothed with bright tawny scales; stipites approximate, 2-6 in. l., straw coloured, nearly or quite naked except at the very base, narrowly margined at the top; fronds variable in size, 3-6 or more in. l. $\frac{3}{4}$-$1\frac{1}{4}$ in. w. lanceolate or oblong-lanceolate, erect, acute-pointed, the base cuneate, very coriaceous and stiff, naked, pale green generally, the rachis raised beneath; veins close simple and forked; fertile fronds usually somewhat smaller, subrounded or less cuneate at the base, the stipites rather longer.—Sw. Syn. t. 1. fig. 1.

Common on decaying logs in forests and coffee plantations from 2000 ft. alt.upwards; much smaller and stiffer than *latifolium,* which in texture and shape it most nearly resembles. It varies in size with the position in which it is found; some specimens, which are fully fertile, from exposed situations are only 2 in. l. in the fronds.

10. *A. latifolium,* Swartz.—Root-stock usually short-creeping, woody, densely clothed with glossy bright or dark coloured scales; stipites few, contiguous or an inch or two apart, strong, $\frac{1}{2}$–1 ft. l, brown or stramineous, slightly channelled, naked except at the scaly base; fronds naked, very coriaceous, bright green, 1–2 ft. l. 2–4 in. w., oblong-lanceolate, tapering equally at both ends, the margins thin, and rachis strong, and prominent beneath; veins very close, mostly forked from the base; fertile fronds smaller, more rounded at the base, the stipites as long or rather longer.—Pl. Fil. t. 135. A. longifolium, Jacq. A. alismifolium, Eat.

a. var. ***A.*** *crassinervum.*—Fronds several, smaller, deeply and freely undulated.

Plentiful in forests chiefly on decaying logs and trees from 1,000 ft. alt. upwards,but most abundant at the higher elevations. The habit of growth is erect or suberect, but not straight and strict as in its near

allies. This is the largest local species of the glabrous section, marked also by its long stipites.

11. *A. viscosum,* Swartz.—Root-stock short-creeping, densely clothed with blackish very fine scales; stipites numerous, crowded, lateral on the root-stock, slender, 3-6 in. l. very finely scaly throughout, light or dark brown; fronds linear-lanceolate, ½-1 ft. l. ½-¾ in w., acuminate or acute, the base tapering or cuneate, chartaceous or subcoriaceous, dark green, lighter beneath; both surfaces viscid, and sprinkled over with stellate minute scales, more densely clothed along the prominent dark-brown midrib beneath; veins simple and forked; fertile fronds narrower, on longer stipites.—Pl. Fil. t. 129. (Very artificial.) Hook. and Grev. Icon. Fil. t. 64.

Very plentiful on open banks at 5,000 ft. altitude. The stipites arise obliquely from the root-stock, along the upper side of which they are confined, and are densely crowded. Those of the barren fronds are a darker brown and only half the length of those of the fertile. The surface is very glandulose and viscid, and the scattered minute lacerate or stellate scales are grayish. Those down the midrib are denser. It differs from *Huacsaro* by the shorter, rather broader, more lanceolate than ligulate acuminate, stellate scales, more glandulose surface, as well as in the characters of the root-stock above described.

12. *A. Huacsaro,* Ruiz.—Root-stock elongated, clothed with small black scales, and quite enclosed by the splint-like bases of the numerous stipites; stipites slender, long-curved at the base, ¾-1 ft. l. light or dark brown, channelled, more or less furnished throughout with minute scales; fronds numerous, linear-ligulate, obtuse at the apex, much tapering at the base, ½-⅝th in. w. ¾-1 ft. l., subcoriaceous, more or less furnished with minute scales, chiefly along the rachis and thin slightly reflexed margins beneath, glandulose, very dark, blackish-brown, the underside lighter; the rachis prominent; veins obscure, close, simple or forked; fertile fronds conform, but the stipites usually longer.—*A. Calagula,* Kl. *A. Ruizianum,* Moore.

Common on open banks at 5000 ft. altitude, especially abundant on the sides of the tender, crumbling wayside banks near the Government Cinchona Plantations; distinguished from the next species by the longer more numerous ligulate fronds, longer stipites, different scales, and peculiar form of the root-stock. The latter though decumbent is not repent, and the fronds spring from all sides of it. It is much elongated, reaching a span or more long, slender and densely clothed with small black scales; the stipites are very numerous, and run, appressed, parallel to it like splints, completely enclosing, and in the outer part concealing it.

13. *A. tectum,* Wild.—Rootstock short-creeping, densely clothed with rather squarrose subulate black glossy scales; stipites rather slender, close, 4–8 in. l. meally looking with pale dark-centred appressed scales; fronds ¾–1¼ ft. l. ¾–1¼ in. w., acuminate with a fine point, tapering likewise to the base, coriaceous; grayish-green, upper surface clothed with deciduous thin gray slightly fimbriate-edged much appressed peltate scales, the under sprinkled over with minute brown stellate ones margins thin and somewhat reflexed, rachis raised beneath and clothed

like the stipites; veins obscure, very close, forked and simple; fertile fronds ⅓rd in. w., on much longer stipites.—*A. rubiginosum*, Fée.

Common on open banks from 3,000–5,000 ft. alt. The scales of the upperside are a pale silvery gray, fine and lightly fimbriate-edged but not stellate, eventually deciduous leaving the surface nearly bare. Those beneath form very minute scattered stellate reddish-brown ciliæ, smaller than in any of its allies which also are more or less deciduous. When naked, though larger and firmer, the species most resembles *viscosum*.

14. *A. auricomum*, Kunze —Rootstock very shortly repent, densely clothed with bright dark-brown ciliate-edged scales; stipites tufted or sub-tufted, several, 1½–2½ in. or more l., freely clothed with spreading, very ciliate, ferruginous scales; fronds pendent, ½–1 ft. l. ½ - 1 in. w. tapering both ways nearly equally, the apex acuminate or acute, even or repand margined, thin, membrano-chartaceous, rusty green, both surfaces sprinkled with dark-brown long-ciliated minute scales, those on the upperside reduced to stellate hairs; rachis slender, clothed like the stems; veins simple and forked, ¾–1 li. apart; fertile fronds smaller, on rather longer stipites.—*A. acuminans*, Fée.

Infrequent on the sides of rocks in open or shaded situations at 2,000-3,000 ft. alt.; gathered in the coffee fields above Mount Moses, St. Andrew. As locally represented this is a smaller species than the next, of thinner texture, and much less and finer vestiture. In vestiture the Guiana specimens quite agree, but they are larger. The species is however very variable in size.

CONTRIBUTIONS AND ADDITIONS.

Library.

Bulletin R. Gard. Kew. Nov. 1897. App. I & II, 1898. [Director.]
Bot. Mag. Feb. 1898. [Purchased.]
Trop. Agriculturist Nov. & Dec. 1897. Jan. 1898. [Purchased.]
Sugar Cane. Feb. 1898. [Editor.]
Pharm. Journal Jan. & Feb. 1898.
W. I. & Com. Advertiser. Feb. 1898. [Editor.]
Chemist & Druggist. Jan. & Feb. 1898. [Editor.]
Quarterly Record, Roy. Bot. Soc., London. July—Dec. 1897. [Secretary.]
Produce World. Jan. & Feb. 1898. [Editor.]
Botanical Gazette. Feb. 1898. [Editor.]
British Trade Journal. Feb., 1898. [Editor.]
Agr. Ledger. Nos. 9-11–13. 16 17.1897. [Supt. Govt. Print. Calcutta.]
Gardener's Chronicle. Feb. 1898. [Purchased.]
Agr. Gazette, N. S. Wales. Dec. 1897. [Dept. of Agr.]
Sugar Journal. Dec. 1897. [Editor.]
Agr. Journ. Cape of Good Hope. Jan. 1898. [Dep. of Agr.]
Central African Times. Jan. 1898. [Editor.]
Bulletin Torrey Bot. Club. Feb. 1898. [Editor.]
American Journ. of Pharm. Feb. 1898. [Editor.]
Farmers Bulletin U. S. Dept. of Agr. [Secretary.]
New Natal Plants Jour. I & II. extr. Journ. Bot. 1897. By J. W. Wood [Author].
Exp. Station Record. [Director.]
Eclectic Medical Journ. Aug. 1897. [Editor.]
Queensland Agr. Journ. Jan. 1898. [Director.]
Times of Ceylon. Jan. & Feb. 1898. [Editor.]

Montreal Pharm. Journ. Feb., March 1898. [Editor.]
Nature. Feb. 1898. [Purchased.]
Bulletin New York Botanical Garden. Jan. 1898. [Director.]
Publications Univ. of Pennsylvania. [Secretary.]
Journ. Roy. Agr. & Com. Soc., British Guiana. Dec. 1897. [Secretary.]
Bulletin U. S. Dept. of Agr. 1897. [U. S. Dept. of Agr.]
Journ. Botany. Feb. 1898. [Purchased.]
Hawaiian Planters Monthly. Jan. 1898. [Editor.]
Sucrerie Indigene et Coloniale. Jan. & Feb. 1898. [Editor.[
Ziekten van het Suikerriet op Java. By Wakker & Went. [Authors.]
Der Tropenpflanzer. Feb. 1898. [Editor.]
Biographische Skizzen. V. By Prof. Urban. [Author.]
Bulletin de L'Herbier Boissier. Jan. 1898. [Conservateur.]
Garden. Feb. 1898. [Purchased.]
Journ. Jamaica Agr. Soc. Feb. 1898. [Secretary.]
Bulletin Koloniaal Museum. 1897. [Director.]
Bulletin Bot. Gards. & Museums, Berlin. Dec. 1897, Feb. 1898. [Director.]
Observations on some West Amer. Thermal Algae. Extr. *Bot. Gaz.* Josephine E. Tilden. [Author.]
Movements of Protoplasm in Coenocytic Hyphae By J. C. Arthur. Extr. *Amn. Bot.* [Author.]

Reports, Bulletins and Records have been received from the following Agricultural Experiment Stations, U.S A.:—

Vermont, Texas, Arizona, Virginia, New Hampshire, California, Idaho, Nebraska, Georgia, Utah, Maryland, Kingston, R.I., Kansas, Utah, Wyoming, Vermont, Amherst, Mass., Oregon, Alabama, Arkansas, New Jersey, Rhode Island, New York, Storrs, Conn.,

---

SEEDS.

From Dr. D. Morris, C.M.G., Kew.
Eucalyptus Lehmanni
E. cornuta
Citrus Bergamia

From Botanic Gardens, Singapore.
Cycas Rumphii

From Botanic Station, Lagos.
Lonchocarpus cyanescens

From Rev. Wm. Griffith, Kingston.
Phytelephas macrocarpa—the Ivory Nut Palm

MUSEUM SPECIMEN.

From Dr. Plaxton, Kingston.
Wood of Pithecolobium Saman.

[Issued 30th June, 1898.]

New Series.] MARCH, 1898. Vol. V. Part 3.

BULLETIN

OF THE

BOTANICAL DEPARTMENT, JAMAICA.

EDITED BY

WILLIAM FAWCETT, B.Sc., F.L.S.

Director of Public Gardens and Plantations.

CONTENTS:

PRICE—Threepence.

A Copy will be supplied free to any Resident in Jamaica, who will send Name and Address to the Director of Public Gardens and Plantations, Kingston P.O.

KINGSTON, JAMAICA:
GOVERNMENT PRINTING OFFICE, 79 DUKE STREET.

1898.

JAMAICA.

BULLETIN

OF THE

BOTANICAL DEPARTMENT.

New Series.] MARCH, 1898. Vol. V. Part 3.

THE AGRICULTURAL CHEMISTRY OF COCOA.

Extract from Report on the Agricultural Work in the Botanic Gardens of British Guiana for the years 1893-4-5. By G. S. JENMAN, Govt. Botanist, and J. B. HARRISON, Govt. Analyst.

Our attention has been directed to the little that is known, or at any rate published in a readily available form, about the agricultural requirements of this important crop. We have, therefore, devoted some time to the study of the chemical constituents and requirements of the Cocoa, and to that of the changes in composition which take place during the fermentation and curing of the beans.

The composition of the different parts of the cocoa tree has been treated upon by Marcano of Venezuela (*a*), and in part by Boname, late of Guadeloupe, now of Mauritius (*b*). Our opportunities for studying the requirements of the plant as represented by the composition of the mature trees themselves being very limited, we prefer to accept for our guidance in this colony the results given by Marcano. This authority estimates that a cocoa tree twenty years old is made up of—

Trunk	49·5
Large branches	21·1
Medium branches	11·
Small shoots	12·
Leaves	6·4
	100·0

and that a plantation of trees of this age growing on one acre will contain—

Nitrogen	201 lbs.
Phosphoric anhydride ...	95 "
Potash	251 "
Lime	400 "
Magnesia	111 "

(a) Essais d'Agronomie Tropicale. V. Marcano.
(b) La culture de la canne à sucre à la Guadeloupe. Ph. Boname.

whilst the so-called suckers and other young shoots trimmed annually from the trees contain*

Nitrogen	... ...	84 lbs.
Phosphoric anhydride	...	49 "
Potash	... ...	42 "
Lime	... ...	66 "
Magnesia	... ...	20 "

These together with the leaves which he states contain—

Nitrogen	... ...	39 lbs.
Phosphoric anhydride	...	7·5 "
Potash	... ...	30 "
Lime	... ...	32 "
Magnesia	... ...	10 "

are practically in all cases yearly returned to the soil.

The fruit, of which the husks may or may not be returned to the soil according as to whether the pods are or are not broken on the field, are estimated to remove as follows:

		If whole fruit removed from the field.	If the pods are broken and left in the field.
Nitrogen	... ...	15·5	8·7 lbs.
Phosphoric anhydride	...	7·9	4·5 "
Potash	... ...	22·1	3·7 "
Lime	... ...	6·5	1·4 "
Magnesia	... ...	2·0	1·0 "

From these figures it appears that the cocoa tree whilst storing up in the plant itself relatively large proportions of the important elements of plant food present in the soil, requires for the yearly production of young shoots, leaves and fruit not less than 138 lbs. of nitrogen, 64 lbs of phosphoric anhydride, 94lbs. of potash, 104 lbs. of lime and 31 lbs. of magnesia. Under careful conditions of agricultural practice, however, of this great annual drain upon the soil but 8·7 lbs of nitrogen, 4·5 lbs. of phosphoric anhydride, 3·7 lbs potash, 1·4 lbs of lime and 1 lb. of magnesia are necessarily removed from it, the remainder becoming more or less available again for plant food by the decomposition of the fallen leaves, prunings and husks upon the land. Of the, in round numbers, 130 lbs of nitrogen returned to the soil a considerable proportion, possibly 20 to 30 per cent. may be lost during the decomposition of the vegetable matter, but where the trees are shaded by the nitrogen collecting Bois Immortel or Oronoque tree (Erythrina velutina and E. umbrosa which are used on the islands, or E. glauca which is used in Guiana) doubtless much of the amount thus lost is recouped to the soil.

Hence, from these considerations, we are led to the conclusion that a good cocoa soil should be one capable of yielding to the tree in the course of years a somewhat high proportion of the important constituents of plant food without exhaustion, and also capable of rapidly rendering again available the large quantities of manurial matter returned to it in the forms of prunings, leaves fallen and broken pods. It must in addition be one in which the course of nitrification readily take place: in other words, a fairly rich friable and well drained soil.

*This estimate appears to us from our somewhat limited experience as excessive.

The following are types of good cocoa soils recently examined in the Government Laboratory :—

	Demerara.	Grenada. No. 1.	Grenada. No. 2.	Grenada. No. 3.	Grenada. No. 4.	St. Vincent.	Trinidad.	Nicaragua.
1. Organic matters & combined water ...	9·031	7·644	10·442	10·993	9·688	3·046	3·768	10·815
Phosphoric anhydride ...	·087	·082	·184	·044	·058	.114	·084	·293
Sulphuric anhydride ...	·018	·118	traces.	traces.	·027	.055	traces.	·141
Chlorine ...	trace.	traces.	nil	traces.	traces.	traces.	nil	·007
Iron peroxide ...	4·783	9.085	9·485	18·672	12·033	9·574	3·910	7·000
Alumina ...	9·217	13·628	10·024	17·140	12·710	8·889	2·038	4·717
Manganese oxide .	·347	·191	·313	·379	.249	·435	·12.	·163
Calcium oxide ...	.596	1·335	2·379	·481	1·183	4·981	·356	2·250
Calcium carbonate ...	.032	·236	·026	·185	·099	nil	nil	nil
Magnesium oxide ...	·404	1·367	3·367	1·261	·680	2·418	·495	·217
Potassium oxide ...	·291	·254	·343	·169	·428	·178	·118	·619
Sodium oxide ...	·208	·393	·574	·197	1·102	·369	·278	1·184
Insoluble silica & silicates	74·986	65·667	62·863	50·509	61·743	69·941	88·826	72·594
	100·000	100·000	100·000	100·000	100·000	100·000	100·000	100·000
1 Containing nitrogen ...	·262	·309	·271	·286	·224	·205	·100	·228
Water retained by air dried soil ...	6.5	8·5	12·4	14·3	9·6	8·1	1·8	8·0

The samples from Grenada, St. Vincent and Demerara were personally selected by one of us, whilst those from Trinidad and Nicaragua were given to us and described as very fertile cocoa soils by J. H. Hart, Esq., F.L.S., the Superintendent of the Botanic Gardens, Trinidad. With the exceptions of the Demerara and Trinidad samples, all are of soils arising from the degradation of lavas and volcanic debris, rich in soda lime felspars. As a rule these fertile cocoa soils are fairly rich in nitrogen, and contain a somewhat high amount of potash of which a relatively high proportion was found to be soluble in 1 per cent. citric acid solution, whilst the proportion of phosphoric anhydride present appears to be of lesser importance. They can, we consider, be safely regarded as reliable types of the composition of really fertile cocoa soils.

In order to obtain reliable data as to the composition of cocoa grown under fairly favourable conditions at low elevations in this colony, we availed ourselves of the kindness of Charles Ross, Esq., of Pln. Land of Canaan, Demerara River. He supplied us with a large number of freshly gathered ripe pods of cocoa of two varieties : 1st the small podded, thick, smooth skinned variety with flat beans, known as Calabacillo ; and, 2nd, the large podded somewhat thick rough skinned variety with full rounded beans known as "Forastero." The former is the variety

agriculturally best suited for our somewhat heavy lands, being the hardiest of all varieties, and giving on low lying land by far heavier yields of cured cocoa than "Forastero" does. In addition we obtained from him cured beans of these varieties. Many other varieties are to be found growing in greater or less abundance in the cocoa groves of this colony including the Criollo or Caraccas kind, but as the bulk of the crops appears to consist of Forastero and Calabacillo cocoa, principally of the former, we confined our attention to them.

We found the fresh pods to yield as follows:—

	Calabacillo.		*Forastero.*
Husk ...	80.59	...	89.87
Pulp ...	7.61	...	4.23
Cuticles of beans	1.77	...	.50
Kernels of beans	10.03	...	5.40
	100.00		100.00

The yields of cured cocoa are 37.5 and 35.6 per cent. of the beans and pulp of the two varieties respectively. Hence 100 lbs. of the fruit of Calabacillo will yield 7.25 lbs of fermented cured cocoa and 100 lbs. of the fruit of Forastero 3.6 lbs. There would appear to be a distinct advantage in growing cocoa of the variety Calabacillo; but the difference in the market value of the small flat beans of this variety and in that of the large plump beans of Forastero very materially reduces the apparent advantage.

The fresh fruits were rapidly divided up into the outer husks, the cuticles of the beans and their adherent pulp, and the inner kernels of the beans or cocoa nibs proper. The cured beans were also divided into the cuticles and inner kernels. After weighing, all parts of the fresh fruit were dried at a temperature of about 140° F. until they ceased to lose weight, the loss of moisture noted, and the dry material carefully ground up and sampled..

Analyses were afterwards made of these portions and the results calculated back to the original state of the fruits as received.

The following show the detailed composition of the fresh fruits of each variety, of the various parts of the fruits, and the distribution of the constituents in the parts of the fruit:—

Whole fruit of Cocoa, variety "Calabacillo."

	Water ...	...	78·790
1.	Albuminoids ...	...	1·370
2.	Theobromine ...	...	·234
3.	Caffeine ...	...	·015
4.	Indeterminate nitrogenous matters	...	·067
	Fat ...	...	3·093
	Glucose ...	...	·274
	Sucrose ...	...	·006
	Starch ...	...	·844
	Astringent matters...	...	2.332
	Pectin, etc. ...	...	1·522
	Cocoa-red ...	...	·888
	Digestible fibre ...	...	5·405
	Woody fibre ...	...	3·122

Tartaric acid free	·324
Acetic acid free	·054
Tartaric acid combined	·716
Iron peroxide	·008
Magnesia	·120
Lime	·042
Potash	·468
Soda	·038
Silica	·007
Sulphuric anhydride	·044
Phosphoric anhydride	·152
Chlorine	·030
	99·967
1. Containing nitrogen	·219
2. " "	·072
3. " "	·004
4. " "	·032
Total nitrogen	·325

Constituents of the various parts of the Cocoa fruit, variety—"Calabacillo."

	Kernel of beans.	Cuticles and pulp.	Husks.
Water	37·637	87·600	82·893
1. Albuminoids	6·696	·918	·760
2. Theobronine	1·352	·241	·094
3. Caffeine	·108	·041	Nil.
4. Indeterminate nitrogenous matters	·531	Traces.	·169
Fat	29.256	·444	·146
Glucose	·991	·725	·132
Sucrose	Traces.	·066	Traces.
Starch	3·764	·945	·469
Astringent matters and tannin	5·004	·395	2·225
Pectin etc.	·657	·815	1·710
Cocoa-red	2·952	·511	·675
Digestible fibre, etc.	5·112	4·652	5·411
Woody fibre	3·030	1·346	3·340
Tartaric acid, free	·079	·439	·341
Acetic acid, free	Nil	Nil	·067
Tartaric acid, combined	·477	·3 3	·794
Iron peroxide	·032	·004	·006
Magnesia	·324	·114	·095
Lime	·054	·054	·039
Potash	·842	·190	·454
Soda	·239	·041	·014
Silica	·016	·002	·006
Sulphuric anhydride	·079	·021	·042
Phosphoric anhydride	·749	·115	·082
Chlorine	·019	·018	·036
	100·000	100·000	100·000
1. Contains nitrogen	1·071	·147	·121
2. " "	·416	·077	·029
3. " "	·031	·012	Nil.
4. " "	·085	Nil	·027
Total nitrogen	1·603	·236	·177

Distribution of the constituents of the fresh Cocoa fruit, variety "Calabacillo."

Percentage of	Kernels of beans.	Cuticles and pulp.	Husks.
	10·03	9·38	80·59
Water ...	3·7751	8·2169	66·7980
1. Albuminoids ...	·6716	·0861	·6125
2. Theobromine ...	·1355	·0226	·0757
3. Caffeine ...	·0[illegible]08	·0038	Nil.
4. Indeterminate nitrogenous matter	·0532	Traces.	·0136
Fat ...	2·9343	·0413	·1177
Glucose ...	·0994	·0680	·1064
Sucrose ...	Traces.	·0062	Traces.
Starch ...	·3775	·0886	37·80
Astringent matters ...	·5019	·0370	1·7931
Pectin, etc. ...	·0659	·0764	1·3800
Cocoa-red ...	·2961	·0479	·5438
Digestible fibre, etc. ...	·5127	·5316	4·3607
Woody fibre ...	·3039	·1262	2·6917
Tartaric acid free ...	·0079	·0412	·2748
Acetic acid free ...	Nil	Nil	·0540
Tartaric acid combined	·0478	·0284	·6399
Iron peroxide ...	·0032	·0004	·0048
Magnesia ...	·0325	·0107	·0765
Lime ...	·0050	·0051	·0314
Potash ...	·0844	·0182	·3659
Soda ...	·0240	·0038	·0191
Silica ...	·0016	·0002	·0041
Sulphuric anhydride ...	·0080	·0020	·0338
Phosphoric anhydride...	·0751	·0108	·0661
Chlorine ...	·0019	·0016	·0290
	10·0293	9·3750	80·4616
1. Contains nitrogen ...	·1074	·0138	0·975
2. " " ...	·0417	·0072	·0233
3. " " ...	·0031	·0011	Nil.
4. " " ...	·0085	Traces.	·0217
Total nitrogen	·1607	·0221	·1425

Whole fruit of Cocoa, variety "Forastero."

Water ...	...	81·877
1. Albuminoids ...	...	1·234
2. Theobromine ...	...	·152
3. Caffeine ...	...	·015
4. Indeterminate nitrogenous matters	...	·175
Fat ...	...	1·800
Glucose ...	...	·927
Sucrose ...	...	·054
Starch ...	...	·780
Astringent matters	...	·424
Pectin, etc. ...	...	1·022
Cocoa-red ...	...	·684
Digestible fibres ...	...	4·097
Woody fibre ...	...	5·055
Tartaric acid, free ...	...	·255
Acetic acid, free ...	...	·053

Tartaric acid, combined	...	·564
Iron peroxide ...	...	·010
Magnesia ...	...	·119
Lime ...	...	·040
Potash ...	...	·368
Soda ...	...	·011
Silica ...	...	·008
Sulphuric anhydride	...	·033
Phosphoric anhydride	...	·147
Chlorine ...	..	·006
		99·910
1. Containing nitrogen	...	·198
2. " " ...	...	·046
3. " " ...	...	·004
4. " " ...	...	·028
Total nitrogen	...	·276

Constituents of the various parts of the Cocoa fruit, variety "Forastero."

	Kernels of beans.	Cuticles and pulp.	Husks.
Water ...	36·567	83 030	84·538
1. Albuminoids ...	4·826	1·271	1·017
2. Indeterminate nitrogenous matters	2 725	Nil.	·031
3. Theobromine ...	·882	·340	·098
4. Caffeine ...	·222	·059	Nil.
Fat ...	30·602	·421	·142
Sucrose ...	·165	1·001	·969
Glucose ...	·917	·091	Nil.
Starch ..	6·038	1·305	·445
Astringent matters ...	4·894	·108	·172
Pectin, etc. ...	1·380	1 126	·995
Cocoa-red ...	1·543	·705	·631
Digestible fibre ...	2·821	6·564	4·045
Woody fibre ...	3·458	2·455	5·288
Tartaric acid, free ...	·038	·606	·250
Acetic acid, free ...	nil.	trace.	·059
Tartaric acid, combined	·487	·351	·580
Iron peroxide ...	·032	·010	·009
Magnesia ...	.454	·073	·101
Lime ...	·105	·030	·037
Potash ...	·635	·248	·358
Soda ...	·068	·015	·073
Silica ...	·016	·0 3	·008
Sulphuric anhydride ...	·048	·031	·032
Phosphoric anhydride	1·045	·098	·096
Chlorine ...	·032	·051	·026
	100·000	100 000	100·000
1. Containing nitrogen ...	·772	·203	·163
2. " "	·436	nil.	·005
3. " "	·271	·107	·030
4. " "	·064	·017	nil.
Total nitrogen ...	1·543	·327	·190

Distribution of the constituents of the fresh Cocoa Fruit, variety "Forastero."

Name of part.	Kernels of beans.	Cuticles and pulp.	Husks.
Per cent of part	5·40	4·73	89·7
Water ...	1·9746	3·9273	75·9750
1. Albuminoids ..	·2605	.0601	·9136
2. Indeterminate nitrogenous matters	·1471	nil.	·0278
3. Theobromine ...	·0476	·0164	·0880
4. Caffeine ...	·0119	·0028	nil.
Fat ...	1·6524	·0199	·1276
Glucose ...	·0089	·0473	·8708
Sucrose ...	·0495	·0043	nil.
Starch ...	·3186	·0617	·3999
Astringent matter ..	·2643	·0051	·1546
Pectin, etc. ...	·0745	.0532	·8942
Cocoa-red ...	·0833	.0333	·5671
Digestible fibre ...	·1519	·3105	3·6352
Woody fibre ...	·1867	·1161	4·7522
Tartaric acid, free ...	·0020	·0286	·2246
Acetic acid, free ...	nil.	trace.	·0530
Tartaric acid, combined	·0263	·0166	·5213
Iron peroxide ...	·0017	·0005	·0081
Magnesia ...	·0245	·0034	·0907
Lime ...	·0056	·0014	·0332
Potash ...	·0343	·0117	·3217
Soda ...	·0036	·0007	·0065
Silica ...	·0008	·0002	·0072
Sulphuric anhydride ...	·0026	·0015	·0288
Phosphoric anydride ...	·0564	.0046	·0864
Chlorine ...	.0016	·0024	·0023
	5·3912	4·7296	89·7898
1. Containing nitrogen	·0417	·0096	·1465
2. " "	·0233	nil.	·0045
3. " "	·0146	·0050	·0270
4. " "	·0233	·0008	nil.
Total nitrogen ...	·0830	·0154	·1780

The fruit of Calabacillo contained less water but distinctly more nitrogen, potash and phosphoric anhydride than that of Forastero. The kernels of the beans of Calabacillo were distinctly richer in the alkaloids, also in astringent matter, and in cocoa-red than were those of Forastero, the result being that the beans of the former variety were of a harsher, more astringent flavour than those of the latter. The beans of the two varieties showed but little difference in their contents of fat, but those of Forastero were of a higher content of starch and sugars. In the cuticles and pulp from Calabacillo there were found somewhat lesser amounts both of the alkaloids and of starch and sugars than in those from Forastero. In the husks of both varieties small amounts of theobromine, less than 1 per cent. were found, but no caffeine, which was present in small quantities in the kernels and cuticles of both varieties, was found in either. But little difference existed in the husks of both varieties in their contents of nitrogen and phosphoric anhydride but those of Calabacillo contained the higher proportion of potash.

When however we take into consideration the higher proportion of husk in the fruit of Forastero, we find that this variety returns more nitrogen, more phosphoric anhydride and but little less potash to the soil in the waste husks than does an equal weight of the fruit of Calabacillo. But it requires double the weight of fruit of Forastero than of Calabacillo to produce an equal weight of cured cocoa, hence the return to the soil by the husks is more than twice as great in the case of the former than of the latter.

Assuming that the average yield here of the variety Calabacillo, is 250 lbs. and that of Forastero 150 lbs. of cured cocoa per acre respectively, we find that the amounts of the constituents of plant food removed from the land annually in the whole fruit, returned to the soil in the husks and either sold in the cured cocoa or lost in the sweatings from the fermenting boxes, are as follows :—

Pounds per acre per annum.

Variety of Cocoa.	Calabacillo.			Forastero.		
Parts of fruit referred to.	Whole fruit.	Refuse husk.	Beans and pulp.	Whole fruit.	Refuse husk.	Beans and pulp.
Weight per acre.	6,200	5,000	1,200	6,900	6,200	700
Nitrogen ...	20·15	8 85	11·30	19 04	11·78	7·26
Phosphoric anhydride ...	9·42	4·10	5·32	10·14	5 95	4·19
Potash ...	29·01	22·70	6·31	25·39	22 19	3·20
Lime ...	2·60	1·95	65	2·76	2·29	·47
Magnesia ..	7·44	4·75	2·69	8·21	6·26	1·95

The unavoidable loss per acre in this colony as compared with that in Venezuela given by Marcano, and with that in Guadeloupe reported by Boname is as follows :—

	lbs. per acre per annum.			
	Demerara.		Venezuela.	Guadeloupe.*
	Calabacillo	Forastero	Varieties not stated.	
Nitrogen ...	11·30	7·26	8·7	7·3
Phosphoric anhydride...	5 32	4·19	4·5	2·8
Potash ...	6·31	3·20	3·7	4·3
Lime ...	·65	·47	1·4	·4
Magnesia ...	2.69	1·95	1·	1·4

There is a general concordance in these results showing the low amounts of constituents necessarily removed from the soil by the production of a crop of cocoa.

In the absence of direct experiments on the manuring of cocoa we have formed our opinion that where the Erythrinæ are used as shade trees, manuring should be directed largely towards the upkeep of the potash and phosphates necessary to enable the shade tress to do their part as nitrogen collectors and that where no shade trees are used the mineral manuring ought to be more largely supplemented by nitrogen. Thus the following mixtures or mixtures of other materials yielding the

* Average return per acre assumed by us to be 450 lbs.

same proportions of nitrogen, phosphates and potash per acre might be advisedly tried on cocoa plantations:—

	Erythrinæ used for shade.		*Not shaded.*
Nitrate of soda ...	1 cwt.	...	2 cwt.
Superphosphate of lime 36 o/o soluble	¾ ,,	...	½ ,,
Potash sulphate ...	1 ,,	...	½ ,,

The materials should be well mixed and applied in quantity according to the number of trees planted per acre around each tree at a distance of about two to three feet from the stem.

Our attention has also been directed to ascertaining the changes which the beans with the surrounding pulp undergo during the operations of fermenting and curing. For this purpose we analysed cured beans of the two varieties from the same plantation on which the samples of the fruits had been grown. The cuticles and the husks of the beans were separately examined, the composition of the whole bean being calculated from the figures thus obtained. The analyses were conducted on precisely the same lines and by the same methods as those of the various parts of the fresh fruit. Unfortunately the two varieties are never, as far as our experience goes, in the West Indian colonies kept separate during fermentation and we were forced to select our samples from out of a very large sample of cured beans of the mixed kinds. Mr. J. H. Hart of Trinidad kindly examined the samples drawn and considered them to consist of typical beans of the two varieties.

The following show the results of these analyses compared with those of the analyses of the similar parts of the fresh fruit dried as before described in the Laboratory.

Compositions of the dried and the fermented and cured beans, cuticles and adherent pulp of Calabacillo.

	Dried.	Fermented and cured.
1. Water ...	5·000	7·169
2. Albuminoids ...	9·704	7·213
3. Indeterminate nitrogenous matters	·681	3·509
4. Theobromine ...	2·023	1·549
Caffeine ...	186	103
Fat ...	38·181	40·744
Glucose ...	2·143	·909
Sucrose ...	·07	·024
Starch ...	5 980	5·249
Astringent matters ...	6·900	5·306
Pectin, etc. ...	1·822	2·671
Cocoa-red ...	4·404	2·420
Digestible fibre, etc. ...	12·048	11·615
Woody fibre ...	5·515	5·503
Tartaric acid, free ...	·629	0 535
Acetic acid, free ...	Nil	·869
Tartaric acid combined ...	·974	1·114
Iron peroxide ...	·044	·105
Magnesia ...	·559	·686
Lime ...	·134	·207
Potash ...	1·312	1·125
Soda ...	·355	·120
Silica ...	·022	·065
Sulphuric anhydride ...	·482	·057
Phosphoric anhydride ...	1·098	1·113
Chlorine ...	·044	·020
	100·319	100·000

1. Contains Nitrogen ...	1·551	1·153
2. " " ...	0·106	·546
3. " " ...	·623	·477
4. " " ...	·052	·029
Total Nitrogen ...	2·332	2·205

Cuticles of Cocoa beans, variety "Calabacillo."

	Dried.	Fermented and cured
Water ...	12·400	12·400
1. Albuminoids ...	6·092	6·750
2. Indeterminate nitrogenous matters	traces	4·006
3. Theobromine ...	1·599	1·023
4. Caffeine ...	·272	·355
Fat ...	2·946	4·000
Glucose ...	4·811	·476
Sucrose ...	·240	·143
Starch ...	6·271	4·865
Astringent matters ...	2·621	2·113
Pectin, etc. ...	5·408	6·140
Cocoa-red ...	3·391	3·000
Digestible fibre, etc. ...	36·388	35·721
Woody fibre ...	8·932	9·840
Tartaric acid, free ...	2·913	·420
Acetic acid, free ...	Nil.	·720
Tartaric acid, combined ...	2·010	3·450
Iron peroxide ...	·026	·057
Magnesia ...	·756	·999
Lime ...	·358	·266
Potash ...	1·260	1·821
Soda ...	·272	·219
Silica ...	·013	·200
Sulphuric anhydride ...	·139	·085
Phosphoric anhydride ...	·763	·912
Chlorine ...	·119	·019
	100·000	100·000

1. Contains Nitrogen ...	·974	1·080
2. " " ...	traces	·640
3. " " ...	·492	·315
4. " " ...	·076	·099
Total Nitrogen ...	1.542	2.134

Kernels of the beans of "Calabacillo" dried, and fermented and cured.

	Dried.	Fermented and cured.
Water ...	5·000	6·080
1. Albuminoids ...	10.202	7.310
2. Indeterminate nitrogenous matters	·809	3·406
3. Theobromine ...	2·059	1.659
4. Caffeine ...	·164	·051
Fat ...	44·574	48·400
Glucose ...	1·510	1·000
Sucrose ...	traces	Nil.
Starch ...	5·735	5·329
Astringent matters ...	7·624	5·972
Pectin, etc. ...	1.586	1·950
Cocoa-red ...	4·497	2·300
Digestible fibre, etc. ...	7·287	6·182
Woody fibre ...	4·617	4·600
Tartaric acid, free ...	·120	·560

Acetic acid, free	...	Nil.	·900
Tartaric acid, combined	...	·726	·624
Iron peroxide	...	·048	·115
Magnesia	...	·493	·621
Lime	...	·082	·196
Potash	...	1·283	·980
Soda	...	·364	·477
Silica	...	·024	·037
Sulphuric anhydride	...	·120	·051
Phosphoric anhydride	...	1·141	1·179
Chlorine	...	·028	·021
		100·093	100·000
1. Containing Nitrogen	...	1·662	1·170
2. " "	...	·129	·545
3. " "	...	·634	·511
4. " "	...	·047	·014
Total Nitrogen	...	2·472	2 240

Compositions of the dried, and fermented, and cured beans, cuticles and pulp of "Forastero."

		Dried.	Fermented and cured.
Water	...	5·000	7·027
1. Albuminoids	...	7·203	6·259
2. Indeterminate nitrogenous matters		3·305	2·641
3. Theobromine	..	1·461	1·402
4. Caffeine	...	·331	·431
Fat	...	37·575	46·263
Glucose	...	1·263	·586
Sucrose	...	1·209	Nil.
Starch	...	8 545	6·337
Astringent matter	...	6·053	3·588
Pectin, etc.	...	2·869	1·457
Cocoa-red	...	2·620	2·883
Digestible fibre	...	10·420	9·070
Woody fibre	...	6.803	6·662
Tartaric acid, free	...	·687	·420
Acetic acid, free	...	trace	·674
Tartaric acid, combined	..	·964	·981
Iron peroxide	...	·049	·078
Magnesia	...	·627	.676
Lime	...	·157	·163
Potash	...	1·033	·945
Soda	...	·096	.195
Silica	...	·022	·051
Sulphuric anhydride	...	·092	·016
Phosphoric anhydride	...	1.370	1.155
Chlorine	...	·089	·040
		99.843	100.000
1. Containing Nitrogen	...	1·152	1·001
2. " "	...	·523	·423
3. " "	..	·440	·422
4. " "	...	·094	·122
Total Nitrogen	...	2·209	1·968

Cuticles of Cocoa beans, variety Forastero.

		Dried.	Fermented and cured.
Water	...	11·840	11·840
1. Albuminoids	...	6·603	6·130
2. Indeterminate nitrogenous matters		traces	3·394
3. Theobromine	...	1·808	·909
5. Caffeine	...	·306	·547
Fat	...	2·186	8·580
Glucose	...	5·200	·714
Sucrose	...	·473	Nil.
Starch	...	6·779	3·682
Astringent matters	...	·561	4·350
Pectin, etc.	...	5·849	5·895
Cocoa-red	...	3·662	3·100
Digestible fibre	...	34·100	31·292
Woody fibre	...	12·753	9·640
Tartaric acid, free	...	3·148	·420
Acetic acid, free	...	traces	1·140
Tartaric acid, combined	...	1·823	3·456
Iron peroxide	...	·052	·218
Magnesia	...	.379	1·035
Lime	...	·156	·224
Potash	...	1·288	2·038
Soda	...	·078	·194
Silica	...	·015	·250
Sulphuric anhydride	...	·161	·122
Phosphoric anhydride	...	·509	·807
Chlorine	...	·265	·023
		99·994	100·020
1. Containing Nitrogen	...	1·056	·981
2. " "	...	trace	·543
3. " "	...	·544	·274
4. " "	...	·087	·155
Total Nitrogen	...	1·687	1·953

Composition of the kernels of the beans dried, and fermented and cured of "Forastero."

		Dried.	Fermented and cured.
Water	...	5·000	6·280
1. Albuminoids	...	7.228	6·130
2. Indeterminate nitogenous matters		4·081	2·525
3. Theobromine	...	1·321	1·480
4. Caffeine	...	·332	·414
Fat	...	45·831	52·120
Glucose	...	·247	·566
Sucrose	...	1·373	Nil.
Starch	...	9·043	6·750
Astringent matter	...	7·329	3·470
Pectin, etc.	...	2·068	·770
Cocoa-red	...	2·311	2·850
Digestible fibre	...	3·969	5·752
Woody fibre	...	5·435	6·200
Tartaric acid, free	...	·057	0·420
Acetic acid, free	...	Nil.	·600
Tartaric acid, combined		·729	·596
Iron peroxide	...	·048	·057
Magnesia	...	·680	.621
Lime	...	·153	·154
Potash	...	·951	·776

Soda	...	·101	·196
Silica	...	·024	·020
Sulphuric anhydride	...	·072	trace.
Phosphoric anhydride	...	1 565	1·210
Chlorine	...	.047	·043
		99·995	100·000
1. Containing Nitrogen	...	1·156	·980
2. " "	...	.653	·404
3. " "	...	·406	·457
4. " "	...	·095	·119
Total Nitrogen	...	2·310	1·960

When the compositions of these substances are given in percentages it is difficult to perceive the changes in composition which may have taken place during the fermentation and curing. We have therefore recalculated the results obtained on the assumption that the fat in the original beans as submitted to fermentation would undergo little or no change during the process; comparison of the compositions of the portions of the fresh fruit submitted to fermentation and of the corresponding amount of the product yielded is thus approximately obtained. These are given for both varieties in the following:—

Changes taking place in the kernel of the beans of "Calabacillo" during fermentation and curing.

	Fresh beans.	Cured beans.	Loss in curing.
Water ...	37·637	3·675	33·962
Albuminoids ...	6·696	4·419	2·277
Indeterminate nitrogenous matters	·531	2·059	1·521
Theobromine ...	1·352	1·003	·349
Caffeine ...	·108	·032	·076
Fat ...	29·256	29·256	Nil.
Glucose ...	·991	·604	·387
Sucrose ...	traces.	Nil.	
Starch ...	3 764	3·221	·543
Astringent matter ...	5·004	3·610	1.394
Pectin, etc. ...	·657	1·178	+ ·521
Cocoa-red ...	2 952	1·390	1·562
Digestible fibre ...	5.112	3·737	1·375
Woody fibre ...	3·030	2·780	·250
Tartaric acid, free ...	·079	·328	+ ·259
Acetic acid, free ...	Nil.	·544	+ ·544
Tartaric acid, combined	·477	·377	·100
Iron peroxide ...	·032	·069	+ ·037
Magnesia ...	·324	·375	+ ·051
Lime ...	·054	·118	+ ·064
Potash ...	·842	·592	·250
Soda ...	·239	·288	+ ·049
Silica ...	·016	·022	+ ·006
Sulphuric anhydride ...	.079	·031	·048
Phosphoric anhydride	·749	·712	·037
Chlorine ...	·019	·012	·007
	100·000	60·442	

Results of fermenting and curing 100 parts of the beans with cuticles and pulps of "Calabacillo."

	Fresh.	Cured.	Loss in curing.
Water ...	61·780	2·702	59·078
Albuminoids ...	3·904	2·719	1·185
Indeterminate nitrogenous matters	·274	1·168	+ ·894
Theobromine ...	·814	·584	·230
Caffeine ...	·075	·039	·036
Fat ...	15·361	15·361	Nil.
Glucose ...	·862	·342	·520
Sucrose ...	·032	·009	·023
Starch ...	2 406	1·979	·427
Astringent matters ...	2 776	2·000	·776
Pectin, etc. ...	·733	1·007	+ ·374
Cocoa-red ...	1·772	·912	·860
Digestible fibre ...	4 847	4·379	·468
Woody fibre ...	2·219	2·074	·145
Tartaric acid, free ...	·253	·201	·042
Acetic acid, free ...	Nil.	·327	+ ·327
Tartaric acid, comb. ...	·392	·420	+ ·028
Iron peroxide ...	·018	·039	+ ·021
Magnesia ...	·225	·258	+ ·033
Lime ...	·054	·078	+ ·024
Potash ...	·528	·424	·104
Soda ...	·143	·045	·098
Silica ...	·009	·024	+ ·015
Sulphuric anhydride ...	·194	·021	·173
Phosphoric anhydride	·442	·419	·023
Chlorine ...	·019	·007	·011
	100·132	37.538	

Results of the fermentation and curing of 100 parts of the beans, cuticles and pulp of "Forastero."

	Fresh.	Cured.	Loss in curing.
Water ...	58·261	2·507	55·754
Albuminoids ...	3·165	2·233	·932
Indeterminate nitrogenous matters	1·452	·942	·510
Theobromine ...	·641	·500	·141
Caffeine ...	·145	·154	+ ·009
Fat ...	16·509	16·509	Nil.
Glucose ...	·555	·209	·246
Sucrose ...	·531	Nil.	·531
Starch ...	3·754	2 261	1·493
Astringent matters ...	2·659	1·280	1·379
Pectin, etc. ...	1·261	·520	·741
Cocoa-red ...	1·151	1·028	·123
Digestible fibre, etc. ...	4·578	3·236	1·342
Woody fibre ...	2·989	2 377	·612
Tartaric acid, free ...	·302	·150	·152
Acetic acid, free ...	trace.	·240	+ ·240
Tartaric acid, comb. ...	·423	·350	·073
Iron peroxide ...	·021	·028	+ ·007
Magnesia ...	·275	·241	·034
Lime ...	·069	·058	·011
Potash ...	·454	·337	·117
Soda ...	·042	·069	+ ·027
Silica ...	·009	·018	+ ·009
Sulphuric anhydride ...	·040	·006	·034
Phosphoric anhydride	·602	·412	·190
Chlorine ...	·039	·014	·025
	99·927	35·679	

Changes taking place in the kernels of the beans of "Forastero," during fermentation and curing.

	Fresh beans.	Cured beans.	Loss in curing.
Water ...	36·567	3·687	32 880
Albuminoids ...	4·826	3·599	1·227
Indeterminate nitrogenous matter	2·725	1·482	1·243
Theobromine ...	·882	·869	·013
Caffeine ...	·222	·243	+ ·021
Fat ...	30·602	30·602	
Glucose ...	·165	·332	+ ·167
Sucrose ...	·917	Nil.	·917
Starch ...	6·038	3·963	2·075
Astringent matters ...	4·894	2·037	2·857
Pectin, etc. ...	1·380	·452	·928
Cocoa-red ...	1·543	1·673	+ ·130
Digestible fibre ...	2·821	3·377	+ ·556
Woody fibre ...	3.458	3·640	+ ·192
Tartaric acid, free ...	·038	·246	+ ·218
Acetic acid, free ...	Nil	·352	+ ·352
Tartaric acid, combined	·487	·350	·137
Iron peroxide ...	·032	·033	+ ·001
Magnesia ...	·454	·364	·090
Lime ...	·105	·090	·015
Potash ...	·635	·455	·180
Soda ...	·068	·115	+ ·057
Silica ...	·016	·012	·004
Sulphuric anhydride ...	·048	trace	·048
Phosphoric anhydride..	1·045	·710	·335
Chlorine ...	·032	·025	·007
	100·000	58·708	

In the case of the variety Calabacillo we find that 100 parts of the fresh material submitted to fermentation and curing lose 62·5 per cent. of their weight of which 59 is water and 3·5 organic and mineral matters. In the kernels of the beans the loss on 100 parts amounts to 39·4, of which 6·5 parts consists of solid constituents.

In the variety Forastero 100 parts of the material submitted to fermentation and curing yield 35·6 parts of cured cocoa a loss of 64·4 per cent. ensuing, of which 55·7 is water and 8·7 solid constituents. The kernels of the beans lose 41·3 per cent. during fermentation and curing, of which 8·4 parts are solid constituents.

It is evident that when submitted to a similar fermentation and curing beans of the variety Forastero lose a higher proportion of their weight than do the small flat beans of Calabacillo.

In both cases a considerable loss of the albuminoid constituents ensued, with, in the case of Calabacillo, an increase in the indeterminate nitrogenous matters. In Forastero, a loss of the latter also appeared to have taken place. In both cases we find a loss of the alkaloid constituents has taken place, this being greater in Calabacillo than in Forastero. A marked loss of the sugars has occurred, and also of the starch, pectin, gums and digestible fibre, this being much greater in the case of Forastero than in that of Calabacillo. The astringent matters and cocoa-red have also decreased in about equal proportions on the two varieties. Little change has taken place in the total quantities of tartaric acid present, but the fermented and cured beans contain a small proportion

of acetic acid not present in the original material. Both varieties have lost some of the more soluble constituents of their mineral ingredients.

Comparison of the losses apparently undergone by the whole material submitted to fermentation and by the kernels of the beans lead to the conclusion that, as might be expected, a certain amount of change in place has occurred in the constituents of the kernels of the beans and the cuticles and pulp The kernels show a much more marked loss of astringent matters than do the whole beans and to this loss much of the improvement in flavour must probably be due.

It is also seen by examination of these results that it is probable that during the sweating process slight changes in the position of the constituents of the beans of the two varieties have taken place leading in some cases to apparent gains of constituents in one or other of the kinds. It was found that the original sample consisted approximately of one-fifth beans of Calabacillo and four-fifths beans of Forastero. The following shows the losses resulting from the fermentation of the mixture and we think may be considered as a fairly reliable indication of the changes which ordinarily take place during the fermentation and curing of cocoa :—

Losses resulting from the fermentation and curing of a mixture of beans of "Calabacillo" and Forastero.'

Water		56·419
Albuminoids		·982
Indeterminate nitrogenous matters ...		·229
Theobromine		·159
Caffeine		Nil.
Fat		Nil.
Glucose		·301
Sucrose		·429
Starch		1·280
Astringent matters... ...		1·258
Pectin		·518
Cocoa-red		·270
Digestible fibre		1·167
Woody fibre		·518
Tartaric acid, free		·130
Acetic acid, free	+	·257
Tartaric acid combined ...		.053
Iron peroxide	+	·010
Magnesia		·021
Lime		·004
Potash		·114
Soda		·002
Silica	+	·010
Sulphuric anhydride ...		·030
Phosphoric anhydride ...		·156
Chlorine		·022

There has occurred a loss in almost all constituents of the cocoa, the only gains being in acetic acid, a product of the fermentation, and in iron peroxide and silica due to dirt and dust picked up during the final drying As a check on the accuracy of these results we obtained a sample of the liquid running from the sweating boxes, the constituents of which consist of matters removed from the fermenting material and we found it contained, with the exception of theobromine, either the missing soluble constituents or the soluble products of their alteration and of that of the less soluble carbohydrates.

Composition of the sweatings from a mixture of Calabacillo and Forastero.

	Water	84·817
1	Albuminoids	·062
2	Indeterminate nitrogenous matters ...	·250
	Glucose	11·604
	Sucrose	·638
	Astringent matter, etc. ...	·354
	Alcohol	·188
	Tartaric acid, free	·340
	Acetic, acid, free	·892
	Acetic acid, combined ...	·290
	Iron peroxide	·038
	Magnesia	·074
	Lime	·029
	Potash	·354
	Soda	·004
	Sulphuric anhydride ...	·021
	Phosphoric anhydride ...	·038
	Chlorine	·007
		100·000
1	Containing Nitrogen ...	·010
2	„ „	·040

Examinations made by us of the process of sweating showed clearly that at first an alcoholic fermentation takes place accompanied by a rise in temperature of the material; later a little acetic ether is produced either as a direct product of fermentation or by the interaction of the alcohol and the acetic acid produced, and that, finally, the fermentation becomes an acetic one, the temperature in the fermenting boxes gradually rising so high as to practically stop the alcoholic fermentation.

The results of our examinations and analyses show that the process of fermentation or sweating in cocoa consists in an alcoholic fermentation of the sugars in the pulp of the fruit accompanied by a loss of some of the albuminoid and indeterminate nitrogenous constituents of the beans. Probably the albuminoid constituents are first changed into amides and other simpler combinations which may be further broken up during the process of the fermentation. Some parts of the carbohydrates other than sugars undergo hydrolysis and either escape in the runnings from the boxes in the form of glucose or undergo in turn the alcoholic and acetic fermentations.

During this change some of the astringent matters to which the somewhat acrid taste of the raw beans is due are also hydrolysed and thus a marked improvement in flavour is gained. Small quantities of the mineral constituents principally of potash and phosphoric acid are removed from the beans in the liquid escaping from the fermenting material. A slight loss in woody fibre is shown, which may be due to loss of portions of the cuticle during the operation of drying.

Our work has necessarily only resulted in a partial and incomplete study of the results of the fermentation. We are compelled, under the conditions of this colony, to leave the study of the changes which take place in various kinds of beans and during variously modified conditions of fermentation to botanists and chemists in colonies and countries where cocoa is an important product. We feel that our work in this line will be fully compensated if it leads others more favourably situated to take

up the study of this interesting and intricate subject, and, at any rate, the record of the investigation may be of some service and guidance to the owners and managers of plantations in the colony and to those contemplating purchasing suitable land for est blishing plantations.

ELEMENTARY NOTES ON JAMAICA PLANTS–II.

2 & 3.—Heteropteris laurifolia, A. Juss.

Golden Vine.

Many of the common wayside plants of Jamaica are the ornaments of English hothouses, and amongst the most charming are species of the family Malpighiaceæ.

The cherry of the West Indies represents that section of the family the species of which are trees or shrubs and have the component parts of the seed-vessel united into a single fruit generally fleshy and coloured forming an attraction to birds who feed on the fruit and disperse the seeds The Golden Vine of plates 2 & 3 is a representation of the other section, the species of which are climbers, and have the parts of the seed-vessel separate from one another, generally provided with wings so that when ripe, the wind scatters them far and wide. Those climbers which have yellow flowers may be called generally "golden vines."

The genus which gives its name to the family commemorates a famous Italian physician Malpighi, who more than 200 years ago, about the same time as the English botanist, Grew, laid the foundations of the science of the anatomy and physiology of plants.

From the bark of species of *Malpighia* is obtained a pectoral gum good for catarrh. A decoction of the fruit relieves the thirst of invalids, and is especially useful in inflammatory and bilious fevers. The fruit is called the West Indian or Barbados Cherry and is often eaten both fresh and in tarts and jellies. Those species which have stinging hairs are known as the Cowitch Cherry.

Byrsonima spicata is known as the Locus Berry or Lotus Berry. The fruit has an agreeable acid flavour, and as it contains gallic acid, a decoction is used as a gargle and has also been prescribed in cases of dysentery. The bark is employed for the same purposes and also in yellow fever. The wood is said to be good for tanning. In Guiana the bark is given in intermittent fevers, and for inflammatory affections of the lungs and bronchia; an infusion is given as an antidote to the bite of the rattle-snake.

Generally, in this family, the wood and bark are astringent, rather rich in tannin, and sometimes also in red colouring matter.

The wood is adapted for beams or rafters for roofs, and is easily worked, sometimes being used in cabinet work and for small ornaments.

The following are the general characters of the family as it occurs in Jamaica:—

Calyx, free from the ovary, in 5 parts, some or all of which have 2 glands on the outside (Plate 2, fig. 3).
Petals 5, usually with a stalk-like part called the claw (fig. 3), inserted on the receptacle (fig. 2).
Stamens inserted with the petals (fig. 2), 10, of which some are occasionally imperfect; the filaments are generally united at the base
Ovary superior (fig 2), composed of 3 carpels (fig 4), united or distinct only at the top, with 3 styles (fig. 5); ovules one in each cell, pendulous
Ripe Carpels, sometimes forming a drupe (as the West India Cherry), sometimes distinct and separating into nuts which are usually winged. (Plate 3).
Seeds exalbuminous.
Trees or shrubs often climbing.
Leaves usually opposite, simple
To put it rather more briefly: amongst Polypetalæ with 10 stamens and superior ovary of 3 cells, Malpighiaceæ may be distinguished as having a glandular calyx, and clawed petals.

The character of the genera and species may be shortly indicated as follows:—

1. Trees or shrubs; fruit a drupe.

Malpighia. Flowers reddish or purplish in axillary rembels or corymbs.
Byrsouima. Flowers yellow in terminal racemes.
Bunchosia. Flowers yellow in lateral racemes. Leaves with 2 glands beneath.

2. Climbers; flowers yellow; fruit composed of nuts, winged in the centre, but only crested in Brachypterys.

Stigmaphyllon. Flowers in corymbs. Stamens 10, only 6 perfect. Wing of nut thickened on upper margin.
Heteropteris. Flowers in panicles (Pl. 2). Stamens 10, all perfect. Wing thickened on lower margin (Pl. 3).
Brachypterys. Flowers in umbels. Stamens 10 some not always perfect. Nut crested, not winged.

3. Climbers; flowers yellow, (except in Triopteris which has blue flowers); stamens all perfect; fruit composed of nuts with wings at the sides.

Triopteris. Flowers blue, panicles of distant racemes. Nuts with 3 wings.
Tetrapteris. Flowers yellow, umbels paniculate. Nuts with 4 wings.
Hiræa. Flowers yellow, corymbs paniculate. Nuts with 2 roundish wings.

Malpighia.

1. Leaves with stinging hairs on under surface.

M. fucata, Ker. Flowers whitish-pink. Leaves large (over 4 in. long).
M. oxycocca, Griseb. Flower purple. Leaves small (not over 4 in. long).

2. Leaves without hairs. Flowers whitish-pink.

M. glabra, Linn. Flowers 3 to 7 together.
M. punicifolia, Linn. Flowers one alone, or only 2 together.

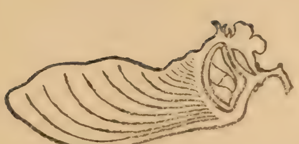
Byrsonima.

B. cinerea, DC. Leaves elliptical, under surface hairy. Anthers hairy.
B. spicata, Rich. Leaves elliptical lanceolate, midrib underneath hairy. Anthers without hairs.
B. jamaicensis, Urb. & Nied. in Jam. Herb. Leaves lanceolate, without any hairs, veins forming a prominent net-work below.

H. A. Wood del.

Heteropteris laurifolia, A. Juss.

1



2

3

H. A. Wood del.

Heteropteris laurifolia, A. Juss.

Bunchosia.

Tree ; leaves large (over 4 in. long.)

B. Lindeniana, A. Juss.

Shrubs ; leaves not large (under 4 in. long.)

B. media, DC. Fruit 2-celled.

B. Swartziana, Griseb. Fruit 3-celled.

Stigmaphyllon.

Leaves with hairs on lower surface.

S. emarginatum, A. Juss. Leaves cordate at base.

S. diversifolium, A. Juss. Leaves rounded at base.

Leaves without hairs on either surface.

S. ciliatum, A. Juss. Leaves fringed on the margin with hairs, stigma leafy.

S. periplocæfolium, A. Juss. Leaves without any hairs.

Heteropteris.

H. parvifolia, DC. Leaf-stalk with 2 glands at the top. Leaves hairy beneath.

H. laurifolia, A. Juss. Leaf-stalk without glands. Leaves without hairs, veins forming a prominent network on both sides.

Brachypterys.

B. borealis, A. Juss. Leaf-stalk with 2 glands at top. Sea-side shrub.

Triopteris.

T. ovata, Cav. Leaves with 2 glands on lower surface close to stalk ; veins reticulated.

Tetrapteris.

T. inæqualis, Cav. Glabrous.

Hiræa.

H. Simsiana, A. Juss. Flower-stalks jointed above the base.

Explanation of Plates of *Heteropteris laurifolia*.

Pl. 2. fig. 1. Flowering branch, ½ natural size.
fig. 2. Section of flower.
fig. 3. Calyx and corolla from outside.
fig. 4. Transverse section of ovary.
fig. 5. Vertical section of ovary.
(figs. 2–5 enlarged).

Pl. 3. fig. 1. Fruiting branch, ½ natural size.
fig. 2. Vertical section of ripe carpel, natural size.
fig. 3. Entire fruit.

CONTRIBUTIONS AND ADDITIONS.

Library.

Bulletin Roy. Gards. Kew. Add. Series I. [Kew.]
Bot. Magazine. Mar. 1898. [Purchased.]
Trop. Agriculturist. Feb. 1898. [Purchased.]
Sugar Cane. Mar. 1898. [Editor.]
Sugar. Feb. 1898. [Editor.]
Pharm. Journal. Mar. 1898.
W. I. & Com. Advertiser. Mar. 1898. [Editor.]
Chemist & Druggist. Mar. 1898. [Editor.]
British Trade Journal. Mar. 1898. [Editor.]
Agr. Ledger. No. 12. [Govt. Print. Calcutta.]
Report Exp. Fields, Dodds Reform. 1896. Barbados. [Supt.]
Agr. Gazette, N. S. Wales. Jan. 1898. [Dept. of Agr.]
Sugar Journal. Jan. 1898. [Editor.]
Ceylon Times. Feb. 1898. [Editor.]
Nature. Mar. 1898. [Purchased.]
Journ. of Botany. Mar. 1898. [Purchased.]
Gardener's Chronicle. Mar. 1898. [Purchased.]

Garden. Mar. 1898. [Purchased.]
Pamphlet by L. H. & E. Pammell. [Authors.]
Investigations in Bark of Trees by Prof. T. Meehan. [Author.]
Agr. Journ. Cape of Good Hope. Feb. 1898. [Dep. of Agr.]
Report Bot. Survey of India. 1896–97. [Director.]
Circular Bot. Gar. Ceylon. Jan. 1898. [Director.]
Hawaiian Planter's Monthly. Feb. 1898. [Editor.]
Sucrerie Indigène et Coloniale. Mar. 1898. [Editor.]
Bulletin de L'Herbier Boissier. Feb. 1898. [Conservateur.]
Rapport over Den Proeftuin 1896–97. By J. D. Kobus & E. W. Van Den Bossche 1878. [Director Proept. O. Java.]
De Wevervogels inhet Snikerriet op. Java. Dr. L. Zehntner 1898. [Director Proept. O. Java.]

Reports, Bulletins and Records have been received from the following Agricultural Experiment Stations, U.S A. :—

Minnesota, Logan, Utah ; Florida, Lake City, Fla ; New Jersey, Geneva, Ontario ; Iowa.

Seeds.

From Botanic Gardens, Brisbane.
Eucalyptus Planchoniana.
E. diversicolor.
E. siderophloia.
E. saligna.
E. marginata.
E. tereticornis.
E. obliqua.
E. pilularis.
E. resinifera.
E. creba.
E. hæmastoma.
E. trachyphloia.
E. maculata.
E. corymbosa.
E. eugenioides.
E. globulus.
Tristania conferta.
Acacia podalyriæfolia.
Morinda jasminioides.
Rhipogonum album.
Geitonoplesium cymosum.
Sarcopetalum Harveyanum.
Myrsine variabilis.
Eustrephus Brownii.
Callitris robusta.
Eugenia Smithii.
Vitis hypoglauca.

From Botanic Gardens, Trinidad.
Monstera deliciosa.

From Messrs. Herb & Wulle, Naples.
Centaurea gymnocarpa.
C. suaveolens.
C. "Margherithæ."
Amarantus hybridus.
Ipomæa imperialis.
I. "Carmen Sylva"
Begonia semperflorens, atropurpurea.
Cyclamen persicum.
Impatiens Balsamina, fl. pl.
Canna "Legionaire."
Coleus hybrids.
Torenia Fournieri, grandiflora.
Vinca rosea var. alba (pure).
Dianthus "Margherithæ."
Lobelia cardinalis.

From Lord Malcolm, Knockalve.
Lagerstrœmia Flos-reginæ.

Plants.

From Mr. A. E. Pratt.
Cattleya labiata. var. Dowiana aurea.

From Mr. Robt. Thomson, Bogota.
Odontoglossum crispum.

From Lord Malcolm, Knockalva.
Buds of Genoa Lemon.

[Issued 21st July, 1898.]

New Series.] APRIL, 1898. Vol. V. Part 4.

BULLETIN

OF THE

BOTANICAL DEPARTMENT, JAMAICA.

EDITED BY

WILLIAM FAWCETT, B.Sc., F.L.S.

Director of Public Gardens and Plantations.

CONTENTS:

PRICE Threepence.

A Copy will be supplied free to any Resident in Jamaica, who will send Name and Address to the Director of Public Gardens and Plantations, Kingston P.O.

KINGSTON, JAMAICA:
GOVERNMENT PRINTING OFFICE, 79 DUKE STREET.

1898.

JAMAICA.

BULLETIN

OF THE

BOTANICAL DEPARTMENT.

New Series.] APRIL, 1898. Vol. V. Part 4.

REPORT ON SUGAR CANES.

By J. Shore.

I.

Canaan Estate, St. James. Canes received from Public Gardens, and planted with some Creole canes on 16th December, 1896; cut 16th March, 1898.

Name of Cane.	Tons Cane per Acre.	Gals. Juice per Ton.	Percentage Extraction.	Gravity of Juice. "Arnaboldi."	Return per Acre.		Remarks.
					Cwt. Sugar.	Galls. Rum.	
No. 49 ...	34	144	71	21	34	128	Grew fairly erect—hardy.
Po-a-ole ...	35½	142	70	21	35½	132	do. do. do.
Tsimbic ...	29	136	67	22	28¼	105	Lodged very much—many canes rotted and rat-eaten.
Caledonian Queen	44½	140	69	23	46	175	Very erect, strong, stout—very long joints.
No. 114 ...	27	140	69	20	25	95	Many canes rat-eaten and spoilt.
No. 99 ...	34	148	70	17	31	113	Fairly erect-strong-likely to ratoon well.
Creole Plants ...	31	138	68	26	35½	178	Ordinary black and transparent canes, usually planted on estates here.
Creole 1st Ratoons	26½	132	65	28	31	155	

The above canes grew in the same field—had no manure nor irrigation.

Land—clayey loam which had been in rich common for 40 years.

Rainfall for 15 months—64 inches 15 parts-fairly distributed and an average fall for that district.

Extent of land covered by this report—8 square chains—lined $4 \times 4\frac{1}{2}$.

Results carefully noted, and proportion of rum fixed as correctly as possible, having due regard to quantity and density of materials.

The *Rum* from new varieties was of appreciably less flavour; but return of *Sugar* was proportionately larger; that of rum was less, than Creole.

Name.	Tons, Cane pre acre.	Remarks.	Number.	Tons Cane per acre	Remarks.
Tourkoury	33¼	Stout & upright	116	44½	Very upright, long joints, stout.
Barkly	26¾	Do. do.	115	36½	Do. do.
Red Rose Ribbon	23¼	Fairly upright	81	35½	Do. do.
Bouroappa	19¾	Do.	345	24	Fairly upright.
Elephant	20	Do.	80	22¼	Do. do.
Seete	19¾	Do.	275	19¾	Do. do.
China	18	Do.	82	18¼	Do. do.
Naga	17½		282	18¾	Do. do.
Grand Savanne	17½		57	18	Do. do.
Brisbane	17		74	17¾	Do. do.
Hillii	12½		343	17¾	
Keni Keni	12½		102	17½	
Nagapoury	12		128	17½	
Norman	8	All grew well, but much damaged by Rats.	105	16½	All grew well, but much damaged by Rats.
Salangore	7½		37	14¾	
Waphendnow	7¼		53	10¾	
Kopo-appa	7¼		78	9	
Bourow	6¼		61	9	
Green Rose Ribbon	6¼		159	8	
Cuapa	5¾		108	7¼	
Vulu Vulu	4½		69	6¾	
Batraime	3¼		45	4½	

The above canes were planted on same soil as previous experiment here reported, and adjoining. The quantity of each was too small to make a detailed synopsis of return of sugar, &c., but the tons cane per acre give an idea of the outturn. The gravity of juice average 24° (Arnaboldi) and the average quantity of juice from one ton cane equalled 143 gallons, extraction 69 per cent.

Most of the varieties were very much rat-eaten; and those lower down on the list were almost entirely destroyed by these pests. It was found also that the ordinary creole "Bamboo" cane was much damaged by rats; the Black and transparent and those higher up on the list suffering little.

AN ANTI-MALARIAL TREE.

MELALEUCA LEUCADENDRON, Linn.

The late Baron Sir F. von Mueller, Government Botanist of Victoria, who did so much for the economic botany of the World, sent to the Director of Public Gardens in April 1895, seeds of a Melaleuca (*M. leucadendron*), to which he thus referred in his letter:—"This tree should become of the utmost importance also to the Western hemisphere. As a tropical tree, fit to grow in malarian swamps, and containing in its foliage much antiseptic and anti-miasmatic oil, it deserves your special attention. It will grow where no Eucalyptus could be reared."

Baron Von Mueller's notice of this tree in his "Select Extra-tropical Plants" is as follows: —

"The Cajaput-tree of India, North and East-Australia as far extra-tropical as 34° south latitude. This tree attains a height of about 80 feet, with a stem reaching 4 feet in diameter, on tidal ground; it can with great advantage be utilised on such intra-tropic areas and in salt-swamps for subduing malarian vapours, where no Eucalyptus will live. The lamellar bark protects it against conflagrations. It is splendid for fruit-packing: oranges kept 4 months in it, lemons 5 months, apples 3 months. The wood is fissile, hard and close-grained, regarded as almost imperishable underground, and resists the attacks of termites (white ants). It is well adapted for posts, wharf-piles, ship-building and various artisans' work. The foliage yields the well-known Cajaput-oil, so closely akin to Eucalyptus-oil. Mr. K. Staiger obtained on distilling the leaves as much as 2 per cent, of oil, which might be manufactured on a large scale from ample material in many parts of Australia. It is rich in Cineol. The tree should be extensively planted where yellow fever occurs."

Young seedlings are now ready for distribution for growing on edges of swamps Application should be made to Director, Public Gardens, Kingston P.O.

WILD OLIVES OF JAMAICA.

It has been stated frequently in the *Bulletin* that the Olive (Olea europæa) has not been known to flower or fruit in Jamaica.

Whenever this statement appears, numerous communications are received to the effect that the writers have seen the Olive tree bearing fruit.

However when specimens are sent to the Herbarium in confirmation, it is seen that there are two or three trees that go by that name, but none of them are the Olive of commerce.

Information given to enquiries on this point has more than once saved the investment of capital in an attempt to introduce and grow the Olive on a commercial scale in places where a "Wild Olive" is known to bear abundant fruit.

XIMENIA AMERICANA, Linn.

One of these wild olives is known botanically as *Ximenia americana* Besides being called a Wild Olive, it is sometimes known either as Mountain Plum, or Seaside Plum. The tree is usually armed with

spines; the leaves are not opposite as in the Olive, they are elliptical and of the same colour on both sides; the flowers are small, yellowish-white, and fragrant; stamens 8, whereas there are only 2 in the olive. The fruit is about the size of an olive, of a yellow colour, with a peculiar aromatic flavour, and delicious perfume; there is one stone, the kernel of which tastes like a filbert. The fruit is useful in cases of habitual constipation and gastric troubles when the irritating action of drastic purgatives has to be avoided; the kernel is more strongly purgative.

Ximenia is a native of the tropics generally. In India the Brahmins often use the yellow wood as a substitute for Sandal wood in their religious ceremonies. (Olacineæ).

Terminalia Buceras, Wright.

Another "Wild Olive" is a near relation of the Broad Leaf (T. latifolia).

It is also called the "Black Olive" or "Olive Bark Tree", and is known botanically as *Terminalia Buceras*.

This tree, 20 to 30 feet high, has horizontal branches, with the leaves crowded together at the ends of the branches, and where they fork. The leaves differ from those of the true olive, not only in the way they grow, but also in being broader towards the tip than below. The flowers have no petals, but the calyx is yellowish, and there are ten long stamens. The berry is only a quarter of an inch long with the remains of the calyx at the top.

The wood is an excellent cabinet wood, and the bark is good for tanning.

Terminalia Hilariana, Steud.

This tree is much like the last except that it grows higher, the flowers are arranged not in a cylindrical but a globose spike, and the berry is twice as large.

Both these trees are natives of the West Indies and the northern part of South America. (Combretaceae).

Bontia daphnoides, Linn.

This shrub or tree is small, 10 to 30 feet high, and is known in the French W. Indies as "Olivier bâtard." The leaves are in shape like the Olive, but they are not opposite. The flower is about an inch long, with a tubular, two-lipped corolla of a yellowish-red colour, and 4 stamens.

A decoction of the flowers is recommended for ophthalmia. The fruit is yellowish, nearly half an inch long, and when quite ripe contains an oil of a yellowish colour, which is employed in colic and other irritations of the intestines.

It may be that it is on this fruit the famous Ring Tail Pigeons get so fat, and acquire their bitterish flavour.

Cuttings of the twigs will grow readily, and planted as a hedge they answer the purpose well.

This tree is a native of the West Indies. (Myoporineæ).

Several trees of the true Olive are growing in the Hope Gardens. They are large trees, but have never flowered. Eighty plants presented by Lord Malcolm, have been planted in the Hill Gardens at elevations varying from 3,500 feet to 5,500 feet, and it is possible that they may fruit there.

METHODS OF PROPAGATING THE ORANGE AND OTHER CITRUS FRUITS.

By Herbert J. Webber, Assistant, Division of Vegetable Physiology and Pathology, U. S. Department of Agriculture.

Reprinted from the Year book of the Department of Agriculture for 1896.

General Remarks.

The methods used in propagating citrus trees do not materially differ from those used in the propagation of other fruit trees. However there are certain differences with which the prospective grower of citrus trees should be familiar, and it is therefore the intention of the writer to briefly describe the principal methods employed by Citrus nurserymen and growers in Florida as a guide for those not already familiar with the industry.

One of the most difficult questions the prospective orange grower must decide is whether to use seedling or budded trees. Such conflicting opinions exist among orange growers in Florida regarding this question that to decide the best policy is confusing and somewhat difficult. The pros and cons of the question, however, cannot be discussed here. Suffice it to say that the general tendency of intelligent and progressive growers is to use only trees budded with thoroughly tested and approved varieties Practically all the advance that has been made in improving citrus fruits by propagating from selected seedlings, hybrids, sports, etc,, which produce superior or peculiar fruits, depends entirely upon propagation by budding and grafting, as the characteristic features are commonly lost by seed propagation. However, many continue to use seedling trees, and there will probably always be some used.

Seedling Trees.

When seedling trees are to be used, the selection of seed becomes an important feature. Any and every orange seed should not be used. On the contrary the greatest care should be exercised in selection. It is not an uncommon report that seeds of sweet oranges frequently produce sour oranges, and vice versa but this is probably never true unless the seeds are the result of hybridization. It is well recognised by growers in Florida, California, and Italy that when seeds of a sweet orange are planted, trees bearing sweet fruit, of a fairly good character, almost invariably result. Orange trees, however, are generally grown in close proximity to lemons, limes, sour oranges, pomelos, etc., and it is not to be wondered at, if hybridization occasionally occurs. When hybridized with the sour orange, lemon, etc., the resulting seedlings may naturally be expected to produce sour, unmarketable fruit, or fruit with rough and unsightly skin While seedlings of the sweet orange almost invariably produce sweet fruit similar to that produced by the parent, there is nevertheless considerable variation wholly aside from that resulting from crossing and hybridizing. This uncertainty as to fruits, especially the finer sorts, reproducing themselves true to seed is what renders budding and grafting desirable in the orange as in other fruit industries.

Where sweet seedlings, or in fact any kind of seedlings, are to be

grown, the seeds should be taken from selected seedling trees known to produce good fruit and which are isolated from citrus trees of other varieties or species. Such selection would prevent the probability of obtaining seeds affected by crossing or hybridizing with other varieties and make it reasonably sure that seedling trees producing good fruit would be obtained. Pomelos, lemons, limes, citrons, kumquats, and the various other species of citrus fruits are almost invariably produced true by the seed, as in the case of the orange, that is, pomelos produce pomelos, lemons produce lemons, etc. Like other fruit trees, however, the different varieties of the fruits named do not reproduce themselves true from the seed. Seedling pomelo, or grape fruit, trees are quite common in Florida. The varieties, however, have not been so much improved as in the case of the orange, and as yet there is but little difference between the fruit of seedlings and that of the best named varieties. The principal varieties or subspecies of mandarin oranges cultivated in Florida, known as the China (commonly called Mandarin) Tangerine, King, and Satsuma, are not infrequently propagated by the seed, and with but slight variation they commonly reproduce true to the parent variety. However, they seldom average equal in flavour to the selected varieties, which must be budded, as they are not reproduced true by the seed. Seedlings of the China are said to show a tendency to form an elongation of the rind at the stem, which makes them awkward to pack. In all cases where seedlings are to be used the greatest care should be exercised to select seed from isolated trees known to uniformly produce good fruit.

The Seed Bed.

The seeds used for planting should in all cases be selected from fully grown normal fruit taken from vigorous, healthy trees. In this case, as in others, it is important that the seed should be good in order to secure vigorous seedlings. The method of extracting the seeds from the fruit most commonly followed by nurserymen and those planting on an extensive scale is to cut the orange in half and squeeze the seeds out into a receptacle. Sometimes the entire fruits are thrown into barrels and allowed to decay, after which the seeds are separated by washing in a coarse sieve, which allows the pulp to pass through. The seeds should be planted immediately, before they have had time to dry, but if this can not be done, they may be preserved moist and in good condition for some time by packing in damp earth. If seeds dry out from necessity or by accident, the great majority of them can be induced to germinate by soaking in water for several days previous to planting.

Many different plans are followed in arranging the seed bed. If only a few seedlings are to be grown, the seeds may be planted in boxes about 8 inches or 1 foot deep and of any convenient size. The soil should be kept moist, but not wet. Mulching the soil with moss (the common Florida long moss) until the plants appear is said by some to be beneficial. If many seedlings are to be grown, it will probably be necessary to plant them in the open ground. In such cases the seeds are commonly sown in beds from 3 to 4 feet wide and about 2 feet apart. Sufficient room must be left between the beds so that the seedlings may be easily cultivated. The seeds sre spread broadcast or are sown in drills, 1 or 2 inches being left between each seed. They are then covered

with soil to a depth of about 1 inch. Some sow the seeds from one half to 1 inch apart in rows about 1 foot apart. (1)

After planting, the seed bed must be either mulched or covered with a shelter of some kind to protect the young seedlings from the sun when they first appear. The cover may be made of brush supported by a suitable frame, or of some thin cloth, like cheese cloth or burlap, such as is used in making fertiliser sacks. The practice of protecting the bed with some such cover is more commonly followed than mulching, and is apparently the preferable method. January is probably the best month for planting [in Florida], although any time will do if care is taken to keep the seeds moist. If planted late in the spring, the dry season [in Florida], of April and May comes before they are thoroughly rooted and is liable to seriously injure them, so that watering may be required. Seeds planted in boxes usually appear in from ten to twenty days, but when planted in open beds they do not appear for about six weeks, although less time may elapse if the beds are artificially watered. The success of the seed beds depend very largely upon cultivation and fertilisation. (2)

Previous to planting, the soil should be fertilised with some non-heating manure, such as well-rotted stable manure or some of the commercial manures for vegetables. Heating manures, like blood and bone or cotton-seed meal, should be avoided, as they are liable to injure the young seedlings. The soil should be fertilised a second time when the plants are from 4 to 5 inches in height, and probably again a third time before they are removed to the nursery. Cultivation should be very thorough, as in the case of vegetables, no weeds being allowed to grow.

The seedlings may be left in the seed bed for a year or more, until they are about the size of a lead pencil at the collar and from 12 to 14 inches in height. Probably the best time to transplant to the nursery

(1) The method found to be the best at Hope Gardens, Jamaica, after extensive experiments, is as follows :—Thoroughly fork up a bed, in virgin soil if possible, four feet wide and as long as necssary, make the soil as fine as possible, spread the seeds not closer than two inches apart on the surface of the bed, which should be about two inches above the surrounding soil. Cover the seeds with fine soil of the best quality to a depth of about an inch. The beds should always be kept moist, but not wet, and free from weeds. As soon as the seedlings have matured their first pair of leaves, transplant the seedlings into other beds similar to those used for the seeds, cut off about a third of the tap root at the time of transplanting so as to cause the plant to send out a large number of fibrous lateral roots. By this treatment a plant two feet high, with a mass of fibrous roots can be grown in about eight months. W.C.

(2) The time of the year for sowing orange seeds must be regulated entirely by the conditions of the local rainfall. The seeds must be sown immediately after the heavy rains, and the transplanting done before the succeeding rainy season. If this is done, and the young plants have recommenced growth after transplanting, there is no danger of their suffering from the heavy rains. But untransplanted seedlings are very liable to be damaged by the rains. No shade whatever is given at Hope Gardens, the seed beds and plants are exposed to the full rays of the sun ; great care being taken to keep the seed and nursery beds as far as possible from trees.

When the young plants are two feet high they are quite ready to be again transplanted, in the case of sweet seedlings to the Grove, and sour seedlings to where they are to be budded. At the second transplanting care should be taken to shorten back all the large roots, especially those inclined to grow straight down. W. C.

is in December or January [in Florida], when the plants are thoroughly dormant. Usually transplanting can be done with safety at any time during the rainy season, but even then it is necessary that the soil should be thoroughly wetted, either naturally or artificially, several times shortly after planting, if the seedlings are to succeed well.

In digging the seedling, carefully thrust a spade down perpendicularly near the plants and work it back and forth until the soil is loosened from the roots, after which the plants may be lifted out without injury. The roots and tops are then pruned preparatory to planting, the tap-root being cut off to about 8 or 10 inches in length and the tops pruned back a corresponding distance. A number of the seedlings may be taken in the hand and the roots and tops cut off with an axe to the desired length. As the seedlings are removed from the bed the roots should be placed in water or wrapped in damp moss or cloth to prevent them from drying out while they are being transferred to the nursery and planted. All small or weak seedlings should be discarded.

The use of Cuttings.

Lemons, citrons, and limes are sometimes propagated by cuttings. Oranges and pomelos may also be propagated in this way, but as they do not root readily this method is seldom used with these fruits. As in other cases, the cutttings are taken from young wood, the twigs being cut into sections from 4 to 6 inches in length, and usually with a portion of one or two leaves remaining attached to the upper end. The base of the cutting is prepared by a smooth, slanting cut made with a sharp knife (a smoothly cut surface forms roots much more readily than a roughly cut surface in which the tissue is injured.) Cuttings thus prepared may be planted in any convenient-sized box filled with sand. The basal end of the cutting is inserted in the soil, leaving about 1 inch of the upper end exposed. Wherever bottom heat can be secured, rooting is greatly facilitated. When the cuttings have sprouted and have attained a height of 8 inches to 1 foot, they may be transplanted to the nursery, as in the case of seedlings.

The Nursery.

The citrus nursery should be on well-drained soil. . . The land should be thoroughly cultivated and all rubbish removed. The trees are usually planted in rows from 4 to 6 feet apart. The tendency of nurserymen is to put the rows a considerable distance apart to facilitate budding and cultivation. The seedlings are planted from 14 to 15 inches apart in the rows. As it is much easier to cultivate straight rows than crooked ones, considerable care should be exercised in laying out the nursery. During the process of planting the seedlings should be kept with their roots in water or wrapped in wet cloth to protect them against drying out. The holes in which the seedlings are to be planted are commonly made by thrusting a spade into the ground and pressing it back and forth until the soil is sufficiently spread. The seedling may then be put in place and the soil pressed firmly around it. The holes in which to set the seedlings may also be made by pressing a nurseryman's dibble into the soil and crowding it back and forth until a space of the desired size is made. The roots may then be spread out and the soil pressed firmly around them. In planting great care should be exercised to get the soil packed firmly around the base of the root and not simply around the collar.

Wherever convenient, it is desirable to use water in planting. The soil must always be moist when seedlings are transplanted, and therefore transplanting should be done soon after a heavy rain, or else the ground should be artificially watered. This is very desirable, not only for the benefit to the plants, but if the soil is dry it is difficult to keep the holes open properly and prevent the dry, hot sand from falling in around the roots. Cuttings are transplanted in the same way as seedlings.

In the nursery, as in the seed bed, thorough cultivation and heavy fertilisation insure success. In fertilising, chemical manures especially prepared for vegetables should be used. About 2,000 pounds per acre of such fertiliser should be given annually in two or three applications. If two applications are to be made, one in February and one in July will probably give the best results. In case of three applications, February, June and August will prove satisfactory periods.

The trees are allowed to remain in the nursery about two years before transplanting into the grove. The second spring after planting in the nursery they have usually attained sufficient size for budding. If it is intended to bud them, they should all be budded at this time, as it is desirable to insert the buds as soon as the trees have attained sufficient size, in order to throw all growth into the bud. If they are budded in the spring, the buds will have reached sufficient size, by fall for the trees to be transplanted into the grove or put on the market as may be preferred.

STOCKS.

The kind of stock used for budding has considerable influence on the health, vigour, and productiveness of the tree. As some stocks will not do well on certain soils and some varieties grow well only on certain stocks, it is desirable that the stock used for planting any given tract be carefully considered. The orange and pomelo, or grape fruit are commonly budded on sweet orange, sour orange, lemon or pomelo stock. If planting is to be done on rich, moist lowlands (low hammocks and flat woods) which are subject to foot rot, or mal-di-gomma, stock which is immune from this disease should be used. Sour orange stock is the most resistant variety that has been found and usually gives the best results. Pomelo, or grape fruit, stock is also quite resistant and is probably the best stock in foot-rot regions where the soil is droughty at certain seasons of the year. It is a more vigorous grower than the sour-orange and resists drought better. Foot rot is common also on some flat woods and high pine land soils which are dry and well drained, and in such localities the pomelo [grape fruit or shaddock] is probably the best stock for general use.

In the case of high and dry lands not much subject to foot rot, sweet orange, lemon, and pomelo [grape fruit or shaddock] are probably the best stocks. On dry lands sour stock, although much used, does not always give satisfaction. Lemon stock, particularly the Florida rough lemon, is a very excellent stock for dry sterile lands, as it is a very vigorous grower, doing fairly well in soil where the sweet-orange would perish. It is so easily injured by cold, however, that it is safe only in southern localities. Pomelo is also a more vigorous grower than sweet orange and is probably a better stock for dry lands, but it is more tender and should be budded near the ground or its use limited to southern regions. In

regions where foot rot is prevalent, sweet-orange stock and lemon stock should never be used, as they are particularly subject to this disease. The lime, which is a very vigorous-growing stock, similar to the lemon, is used to some extent in southern Florida as a stock for the orange, and is said to be excellent for barren scrub land and rocky locations. The hardy trifoliate orange is used to a limited extent as a stock for the orange, but has not always given thoroughly satisfactory results.

Tangerine and China (Mandarin) do well on any of the stocks used for the common sweet orange, but as the grower usually desires to increase the size of these varieties it is probably preferable to bud them on rough-lemon stock. The satsuma, which is a hardy variety, is very extensively budded on the hardy trifoliate orange, on which it is said to do well It also gives good results on sweet-orange, which is probably the best stock to use in southern locations, but does not do well on sour-orange stock. Lemons are usually budded on rough-lemon, sour-orange, or sweet-orange stock, the rough-lemon being considered the most desirable, as it is the most vigorous grower. In places where foot rot abounds, sour-orange stock should be used.

In selecting stocks it is also important that the latitude and local climate be carefully considered. The various citrus species used as stocks for grafting or budding vary greatly in their resistance to cold. . .

In regard to the effect of stock on the character of the fruit, it may be said that while some growers claim to have observed that the fruit is rendered coarser and thicker skinned by budding on vigorous, rapidly growing stocks, like the pomelo and the lemon, yet it is certain thst the difference is very slight and in most cases hardly perceptible. In this connection all that needs to be considered is that stocks of this nature tend to produce rather larger fruits. While in some varieties this character is a disadvantage, it is, on the other hand, an advantage to have a vigorous stock, as in certain varieties this is necessary to insure fruitfulness. The varieties of the Navel orange are unfruitful on sweet or sour stock but usually they are normally prolific if budded on rough lemon.

Budding.

WHEN TO BUD.

The trees in the nursery should be budded when they have attained a size of from one-half to one inch in diameter. If the trees are grown for sale it is probably best to wait until they are three-fourths to one inch in diameter before budding. If the young trees are grown for planting, it may be desirable to bud them rather sooner, in order to put them as soon as possible in their permanent places in the grove. If a tree is transplanted when still small, the greater portion of the roots and top is saved, and the shock in transplanting is therefore less. Budding can be done only when the tree is in a growing condition, so that the bark slips and separates easily from the wood. It is usually preferable to bud as early in the spring as possible. The nursery is commonly budded during March and April. It may be gone over again in May and those stocks which failed the first time rebudded. Budding may be done at any time during the summer, unless the trees are checked in growth by a severe drought, but it is usually not best to bud later that the first of July, as sufficient time should remain fer the bud to push and mature the wood

of the first growth before winter. If the budding can not be done by the time named, it is probably best to wait and put in dormant buds in October or November.

Selection of Buds.

Bud wood should always be selected from fairly well-matured wood of the current year's growth. Round sticks (or as nearly round as possible) should be selected. The young growth of orange wood is at first angular, becoming rounder as the twig matures. The basal portions of the young branches, which are nearly or quite round supply the best buds, with the exception of the first two or three, which are usually somewhat imperfect and should be discarded. Where it is difficult to secure well-rounded wood, angular wood which is not too soft may be used. This, however, is not quite so satisfactory. Thorny bud wood should never be used when other wood can be obtained. Thorny trees are very undesirable, and a careful selection of thornless bud wood will soon result in thornless trees. The thorns have been bred out of many of the best citrus varieties, and if nurserymen would exercise proper care all the desirable varieties could soon be rendered thornless.

The bud wood should be cut while the wood is dormant, before the buds show any signs of pushing. That desired for spring budding should be cut the latter part of January. It is well to leave the wood on the tree as long as possible, and therefore the trees should be carefully observed during this period. When the first buds are observed to be swelling, all the bud wood desired should be cut immediately. After cutting, the leaves should be pruned off and the twigs cut into sections of the desired length. To preserve the bud wood until needed, the twigs should be tied up in convenient-sized bundles, carefully labeled, and packed in old sawdust in a box of suitable size. The box should then be closed and buried in sheltered ground several inches below the surface. In this way bud wood can be preserved in good condition for from two to three months. Dampened sphagnum, or peat moss, may be used instead of sawdust, but in this case considerable care must be exercised to get the moss properly dried. It must be moist, but not wet, for if too wet the bud wood may mould. The same caution applies also to sawdust. In this case, the proper degree of moisture can be secured by taking the material from the interior of an old pile Sawdust does not lose its moisture readily and is the best material for packing. Some simply bury the bud wood in the soil under shelter, digging down until the moist earth is reached.

Materials.

Before beginning the operation of budding, material should be provided for wrapping the buds. For this purpose cotton cord, yarn, strips of waxed cloth, etc., are used. The last named has practically superseded all others in Florida, being more convenient and giving better results than any other wrapping material. The strips are made from strong muslin or calico. Before the cloth is torn into strips, it is folded into convenient size and dipped into a hot solution of wax made by melting together two parts of beeswax and one part of resin. Several formulas for making this wax are used, any one of which will probably answer. The method described is known from personal experience and observation to give good results. After saturating the cloth with the hot wax, all the superfluous wax should be removed before the cloth

cools. To accomplish this quickly hang the piece of cloth, folded in convenient form before waxing, over a small, strong stick which is held by an assistant. Then take two similar sticks of wood and holding them parallel on either side of the cloth press them firmly together and pull downwards, squeezing out the superfluous hot wax. The cloth should then be spread out until cool, after which it is ready to be torn into strips of the desired size, that is, one-fourth to one-half inch wide and from 10 to 12 inches long. The cloth may be torn into strips before it is taken into the field, or it may simply be torn into convenient-sized pieces and afterwards torn into strips in the field as desired for use. The latter is probably the most convenient way. Using waxed cloth for wrapping effectually excludes moisture, prevents the bud from drying out, and the work can be done more quickly than with string, as the strips cover more surface and do not require tying, the wax serving to hold the cloth firmly in place. It may therefore be recommended as far preferable to any other wrapping material.

How to bud.*

Budding is a simple process, consisting in inserting a bud of a desired variety under the bark of the stock in such a way that the freshly cut inner bark of the bud comes in close contact with the layer of growing wood (cambium) of the stock. The bark is closed over the inserted bud and the stock wrapped with waxed cloth, as described, so that the bud is firmly pressed against the growing wood. If the operation is properly performed, the tissue of the bud and stock soon fuse together and the bud may be forced to grow.

In all varieties and stocks of citrus fruits the process of budding is practically the same, the method commonly employed being that known as shield, or eye, budding. The bud is inserted in the young stock near the ground. Previous to the severe freezes of the winter of 1894-95 the general practice was to insert the buds 12 to 18 inches above the ground, but since then the tendency is to bud as near the surface of the soil as possible, so that the trees may be readily banked with the earth above the bud to protect against injury from freezes. Most of the buds are now inserted from 2 to 6 inches above the soil. In sections where foot rot is abundant and sour-orange stock is used as a preventive measure the buds should be inserted from 12 to 18 inches above the soil, so that the sweet-orange wood will be above the influence of the disease.

All leaves and limbs which would hinder the proper wrapping of the buds should be cut away with a sharp budding knife. The use of sharp tools is the secret of success. A vertical cut about 1½ inches long is made at the point where the bud is to be inserted. At the base of this a horizontal cut is made, so that the two cuts presents the appearance of an inverted T. The cuts should not be deep. The aim should be to merely cut through the bark, but no injury will result if the cuts are rather deeper. The lower edges of the bark are slightly raised with the end of the knife blade to facilitate the insertion of the bud. This may also be accomplished by giving the knife an upward turn aftor making the horizontal cut. Now, take a stick of bud wood in the left hand and cut out a bud. Formerly the portion of the wood cut out with the bud was removed, but experience has shown that this is entirely unnecessary.

---

* See also Bulletin, December, 1895.

The upper end of the bud is inserted under the slightly raised ends of the bark and gradually pushed upward until all portions of the cut face of the bud come in contact with the wood of the stock. If in proper condition for budding, the bark of the stock readily separates, allowing the bud to be pushed upward into position. The bud is now ready to wrap. Take a strip of the waxed cloth prepared as above, and beginning slightly below the horizontal cut wrap tightly round the stock over the bud in a spiral manner, each turn slightly overlapping the previous one. The wax holds the cloth in place and makes it possible to draw it very tight. When the vertical incision has been entirely covered, turn the end of the strip slightly downward over the wrapped portion, to which it adheres more firmly than it would to the bark, and no tying will be necessary It is better to wrap from below upward, as in this case each turn overlaps the other in the right direction to prevent water running down the stem from entering. Nurserymen usually wrap over the bud, covering it entirely. Some, following the practice commonly used in other fruits, leave the eye of the bud exposed. This, however, is more troublesome and does not succeed so well.

In some cases where bud wood of certain varieties is difficult to secure, it may be desired to use buds from the young angular wood. This may be used with good results if the stock to be budded is growing rapidly and is in a succulent condition. In this case the method of cutting and inserting the bud is slightly different from that already described. In cutting the buds the stick is turned slightly to one side so that as the bud is cut off the eye lies on one side instead of in the centre of the bud It is only by cutting the bud in this way that the cut surface is made wide enough to hold the bud firmly in position. For inserting these buds an incision is made in the bark. The bark is slightly raised on one side with the point of the knife and the bud is slipped under in a lateral direction, the eye remaining in the vertical slit. The bud is then wrapped.

UNWRAPPING THE BUDS.

In from ten to twelve days the buds will have united with the stock and may then be unwrapped. In early spring, when the weather is cool and the growth slow, the wrapping should be left on from fifteen to twenty days, while in the summer, when the weather is warm and the growth rapid, ten days is usually a sufficient length of time. However, it is impossible to say definitely how much time should elapse before the wrapping should be removed as the wood of the stock should never be allowed to grow over the buds It should not be removed until a light greyish line of new tissue can be seen forming around the edge of the incision made in inserting the bud. A little experience will enable one to tell at what stage it is safe to unwrap. Under ordinary conditions from twelve to fifteen days will give good results, but in very dry weather in the summer, when growth is slow, it may be necessary to leave the wrapping on for a longer time. Some ten days after budding an examination should be made of the number of the buds and if they are found to be well healed on, the wrapping may be taken off, but if not, the wrapping should be replaced and allowed to remain some time longer. If the wraps are allowed to remain too long the wood of the stock is liable to grow over the buds and greatly hinder their pushing.

FORCING THE BUDS.

In order to force the buds to push uniformly after they have healed on it is necessary to severely check the growth of the stock This is most commonly accomplished in nursery trees by lopping the tops, as it is called, which is usually done from three to five days after the wraps are removed from the buds. The lopping is usually done with pruning scissors, the knife edge being placed about 2 inches above the bud and the stock cut two-thirds through. The top is then bent over to one side and allowed to rest on the ground.

To provide for subsequent cultivation and attention it is necessary to use some definite plan of budding and lopping in the nursery. Two methods most commonly followed by Florida nurserymen are to lop the tops of two adjoining rows into the same centre, keeping the alternate centres free for cultivation, or to lop the tops of alternate rows in different directions, one row in each centre, and place them near the rows. By the latter method a cultivator may be run up one row and down the other, passing always in the direction in which the tops are inclined so that the branches will not interfere with the cultivator. Usually the old tops are allowed to remain attached until the buds have attained a height of from 12 to 18 inches, after which they may be cut off.

Some nurserymen have found that the buds make a larger growth if the old tops are allowed to remain attached through the summer and are cut off in September. If this practice is followed, two rows of trees should be lopped together. The tops thus form a dense shade or sort of mulch on the soil, keeping it moist and preventing the weeds from growing. In this case it is also desirable that the rows lopped together should be planted rather close (about 3 feet apart,) for if this is not done the weeds will grow up among the tops, making it necessary to cut off the latter when the buds are 1 foot to 18 inches high in order to keep the weeds down. In the case of vigorous-growing stocks, like the rough-lemon. it is said to be very desirable to leave the tops attached for some time.

When the old tops are removed, the portion remaining above the bud should be cut off smooth and close to the bud, so that it will soon heal over without forming an ugly scar. Some follow the practice of coating the freshly cut end with schellac, but others working on an extensive scale never do this. It is seldom that any noticeable benefit is derived from the practice.

Growth of the Buds.

The attachment of the rapidly growing bud is at first very weak and it is necessary to strengthen it by tying to a stake. Some nurserymen practice cutting the stock rather high in lopping, and support the buds for a time by tying them to the remaining portion of the stock. The buds push much better, however, when the stocks are cut very close in lopping, so that it is hardly desirable to depend upon this method of supporting the buds, as in either case it is necessary later to supply the supporting stakes.

The development of the buds should be carefully watched during summer, and they should be pruned in such a way as to produce a top of the desired shape. In Florida, where a low tree is desired, it is necessary to nip the tops when they are 2 or 3 feet high to induce branching. The buds which push low down on the stock or bud should be

rubbed off before they have grown to any size, as their growth detracts from the development of the bud.

The best time for transplanting orange or other citrus trees is probably during December [in Florida,] although they may be transplanted in January or February or during the rainy season. By December buds put in early in the spring have reached a convenient size for transplanting into the grove.

Dormant Budding.

Putting in buds which are intended to remain dormant during the winter, or dormant budding, as it is called, is usually done in October or November. The process is exactly the same as described above, except that the tops are allowed to remain standing until the following spring. They are lopped in the usual manner the latter part of February, or just before the spring growth starts. The advantage of dormant budding is to secure the first spring growth in the bud, which is the largest growth of the year.

Sprig Budding.

This is a form of budding frequently used on old stocks, where the bark is thick, in changing the variety or replacing a limb accidentally broken off. A scion about 4 inches long is selected, and the basal end sharpened by a slanting cut on one side. A curved oblique incision is made in the bark, the lower edge of which is slightly raised with the point of the knife, and the end of the scion inserted and pushed between the bark and wood in an oblique direction until the freshly cut surface of the scion comes in contact with the growing wood of the stock. The scion is held firmly in place by the bark of the stock, and the use of grafting wax or wrapping of any kind is said, therefore, to be unnecessary.

Grafting.

Grafting has not been extensively used in citrus culture in Florida, but as there is an increasing tendency to place the point of union between stock and graft, or bud, near or below the surface of the soil, this method will probably be more used in the future. There seems to be no good reason why it should not be adopted wherever desirable. Grafting should be done in January or February, while the trees are still in a dormant condition. The scions must be taken from thoroughly mature wood of the last season's growth. Round and thornless twigs should be selected if possible, although the somewhat angular wood may be used if thoroughly mature

Cleft Grafting.

Cleft grafting, which is one of the simplest methods, may be used to advantage in place of budding in nursery trees where it is desired to place the point of union below the soil. A scion about 5 inches long is selected and the lower end sharpened to a wedge shape by two slanting cuts 1½ inches long on opposite sides. The young stock to be grafted is cut or sawed off slightly below the surface of the soil and a cleft made in the stock. If the stock is larger than the scion, the latter must be inserted at the side, so that its cambium layer (the growing layer between the bark and the wood) on one side will come in contact with that of the stock. After the scion has been pushed down into

place, the stock should be wrapped with strips of waxed cloth, like those used in budding, one or more strips being put across the top of the stock to keep the sand out of the cleft until the grafts starts to grow. The moist soil is then thrown up around the graft, leaving only the upper end exposed. The wrapping cloth will decay in a short time, but it is probably best to remove it soon after the grafts begin to grow.

Tongue, or Whip, Grafting

In grafting small stocks the tongue, or whip, graft is generally used. If properly made, the tongue serves to hold the scion firmly in place and forms a good union. After the scion and stock are placed together, they are firmly wrapped around the point of union with strips of waxed cloth, as in the case of buds. The wrapping should be left on until the graft has started well, when it should be removed. By removing the soil somewhat around the collar the tongue graft may be used on small nursery trees to place the union below the surface.

Crown Grafting.

When the tops of comparatively large trees (3 inches or more in diameter) are killed to the ground by freezing or in any other way which leaves the roots uninjured, they can be most quickly replaced by crown grafting. This method of grafting may be used to advantage on large limbs also. In crown grafting, as practiced in Florida, a scion about 5 inches in length is sharpened at the basal end by a long, slanting cut on one side. In crown grafting other fruits a slight shoulder is usually left on the scion, and this rests on the stock when the scion is inserted. When frozen or killed down, the stock to be grafted is sawed or cut off 2 or 3 inches below the surface of the soil, where the wood is fresh and living. With the aid of a knife blade the bark is then slightly loosened from the wood at one place and the scion is pressed in between the bark and wood, with the cut surface against the latter. The best places to insert the scions are in the concave portions of the trunk, as here, in order to allow their insertion, the bark can be pressed out without breaking. Several scions may be inserted on one trunk if desired. The bark, if unbroken, will hold the scion firmly against the wood and no wrapping will be required. If, however, it should be necessary to split the bark to allow the insertion of the scion, it should be wrapped with string or waxed cloth to hold it firmly in position. Moist earth is then banked up over the stump until only the upper portion of the scion remains exposed. In using crown grafts above the soil, strips of waxed cloth or grafting wax must be used to prevent the scions from drying out.

Root Grafting.

Propagating citrus fruits by root grafting has never been thoroughly tested, so far as the writer is informed. In March, 1895, the writer was led to make several tests of this method, which, owing to the condition of some of the roots used, though not thoroughly satisfactory, yet strongly indicated that the method might frequently be used to advantage. About the first of April lateral roots, varying from one-half to three-fourths of an inch in diameter, were taken from sweet-orange trees and cut into sections about one foot in length, each having a fair quantity

of fibrous roots remaining uninjured. These were immediately tongue grafted with dormant sweet-orange scions obtained from California, and were then planted, the union being placed slightly below the soil. The majority of the grafts started growth promptly, but about one-half of these made very slow progress, the growth appearing unhealthy. The roots used were taken from trees about sixteen years old which had been frozen to the ground two months before, and this, it is thought, affected the results. While not recommending the general use of this method, the writer would suggest that the results obtained indicate that a bearing grafted tree may be secured in this way in far shorter time than by any method now practiced. The method would seem particularly promising where lemon, lime, or pomelo stocks, which root easily, are used.

All the methods of budding and grafting described may be greatly changed in detail. No attempt has been made to describe all variations, only those methods being given which have proved most satisfactory and are most commonly used.

Inarching.

Inarching consists of uniting limbs of the same or different trees by a process similar to budding. Several methods of inarching are used, but only the one in most common use will be described. The two limbs to be inarched must be close together, in such a position that one may be easily bent over against the other. The operation is practicable only where one of the limbs is comparatively small—under one inch in diameter. The small limb is cut off by a slanting stroke in such a place that the cut surface faces the other limb when bent over against it at a point where the union is to be made. A vertical and a cross cut like an inverted T (⊥) is made in the bark of the large limb or stalk at the point where the two limbs touch. The end of the small limb is then pushed up into the slit as in shield budding described elsewhere and strips of waxed cloth are wound around the union to hold the limbs firmly in place. The wrapping should be allowed to remain for a month or more till the limbs have become very firmly grown together. Inarching is frequently used in cases where trees are girdled by foot rot, wood lice, or white ants (Termites) or in any other way. In foot rot, young sour-orange stocks, which are immune from this disease, may be planted by the side of trees in the first stages of the malady and inarched into them $1\frac{1}{2}$ or 2 feet above the ground. In this way they may almost certainly be saved from the disease. If the bark of the diseased tree will not slip, a wedge-like union, similar to the cleft graft, should be tried, the incision in the stock being made with a chisel. In case of girdling by white ants or animals, sprouts from the roots may be inarched, or small trees may be planted by the side of the injured tree and inarched, as in the case of foot rot. Inarching is also frequently employed where it is desired to throw the strength of two or more sprouts into the development of one top, as in the case of numerous sprouts coming up around large frozen trunks. Limbs may be braced and strengthened by binding them together by means of inarching branches.

ANALYSIS OF CUBA TOBACCO SOIL.

The following analysis was published in Bulletin No 19 of the Experiment Station at Lake City, Florida, 1892.

The soil was taken from a Tobacco field in Cuba. The analysis was made by Dr. J. J. Earle, Prof. of Chemistry in Agricultural and Mechanical College.

		Per Cent.
Moisture at 110°	...	14.20
Organic matter	...	12 30
Sand and insoluble matter	...	30.32
Carbonic acid (CO_2)	...	4.20
Sulphuric acid (SO_3)	...	.12
Oxide of Iron (Fer O_3)	...	29.40
Oxide of Lime (Ca O)	...	7.60
Oxide of Magnesia (Mg O)	...	.17
Phosphoric acid ($P_2 O_5$)	...	1.60
Potash (K_2 O)	...	.16
Soda (No_2 O)	...	.084
		100.154
Nitrogen to	...	.32
Ammonia	...	.39

The Sulphuric acid is combined with the lime to form sulphate of lime (gypsum). The remainder of the lime is combined with the carbonic acid to form carbonate of lime, and with the phosphoric acid to form phosphate of lime.

FERNS: SYNOPTICAL LIST—LI.

Synoptical List, with descriptions, of the Ferns and Fern-Allies of Jamaica. By G. S. Jenman, *Superintendent Botanical Garden, Demerara.*

15. *Acrostichum muscosum,* Swartz.—Rootstock stout erect, very densely clothed with long linear acuminate, reddish-brown slender scales; stipites tufted, strong, 3-8 in. l., densely clothed with two kinds of bright rather tawny scales, one small and appressed, the other large, loose and spreading; fronds erect, lanceolate-oblong, ½ - 1 ft l. 1½ - 2½ in. w., rounded at the apex, the base cuneate or nearly rounded, the margins often repand and uneven, coriaceous, dark green beneath the vestiture, both surfaces equally scaly, the scales generally diffused but not very dense, those of the upper side pale and more appressed, ultimately deciduous, beneath tawny, ciliate-edged, most plentiful along the costa and edges; veins obscure, ¾ - 1 li. apart, forked; fertile fronds much narrower and on longer stipites.—Pl. Fil. t. 126.

Common on the branches of trees in damp forests at 5,000 - 6,000 ft. alt; well distinguished by the upright rootstock, tufted stipites with abundant large spreading scales, and erect round-ended fronds. It has similar pale bleached scales to *lepidotum* on the upper surface, which also becomes naked in time, though as it grows in more sheltered situations not so quickly or completely as in that species. The forms from

the mainland differ in some particulars from the Jamaica plant which I have described and which is, no doubt, the type of the species.

16. *A. lepidotum,* Willd.—Rootstock short-creeping, densely clothed with glossy blackish scales; stipites contiguous, 5 - 8 in. l., coated throughout with appressed pale, or at first, rather fuscous scales; fronds $\frac{3}{4}$ - $1\frac{1}{4}$ ft l. $\frac{1}{2}$ - 1 in. w.. accuminate or bluntish at the apex, the base tapering, coriaceous, dark green beneath the vestiture, upper surface covered by a thin coating of very pale much appressed lanceolate scales which at length drops off leaving it naked, the under densely matted and glossy with imbricating tawny or fulvous ciliate-margined scales which are persistent; veins close, obscure; fertile fronds somewhat reduced, terminating abruptly at the unequal base, the stipites longer. Pl. Fil. t. 139. *A. vestitum* Schlecht.

Common on open banks at 4,000 - 5,000 ft. altitude. This of all the species is the most densely coated on the under surface. The scales of the upper side are very deciduous, so that the mature fronds are naked above and densely coated beneath, by which feature the species may be immediately recognised. The abrupt termination and unequal sides at the base of the fertile fronds, shown particularly in the larger ones, is also a good distinguishing character not possessed by any other of these species. In the partially developed state of the fronds, the scales of the stipites are squarrose.

17. *A. squamosum,* Swartz.—Rootstock short, stout, densely clothed in glossy, blackish ciliate-edged scales; stipites 4 - 8 in. l., copiously furnished with spreading dark-fringed and ciliate reddish brown scales; fronds pendent, $\frac{1}{2}$ - $1\frac{3}{4}$ ft, l. 1 - 2 in. w., tapering at the base, the apex acuminate, flaccid when fresh, drying sub-coriaceous, dark rusty green, freely clothed, especially beneath, and on the rachis above and along the margins, with reddish-brown copiously ciliated scales; veins simple or forked, $\frac{3}{4}$ - 1 li. apart; fertile fronds $\frac{1}{2}$ - $\frac{3}{4}$ in. w. on longer stipites.

Very abundant on trees in forests above 5,000 ft. alt., a fine species, easily recognised by its abundant clothing of bright reddish brown scales, which along the margins form a distinct fringe. Except on the rachis they are much more plentiful and larger on the under side than on the upper. It presents two states the larger of which is much less common than the smaller, but there are no other variations between them.

18. *A. hybridum,* Bory.—Rootstock short, or shortly elongated, densely clothed with dark, fine, almost hair-like scales; stipites tufted or sub-tufted, slender, 3 - 6 in. l. sparsely clothed with spreading dark hair like scales; ultimately naked, light brown; fronds spreading or pendent, $\frac{1}{2}$ - $1\frac{1}{4}$ ft. l. $1\frac{1}{2}$ - 3 in. w, oblong or linear-lanceolate, acuminate, the base cuneate, chartaceous, or hardly firmer, very pellucid, bright green, rather paler beneath, with a slight fringe of dark hairs aiong the somewhat thickened margin while immature, quite naked with age; veins simple or forked, $\frac{3}{4}$ - 1 li. apart; fertile fronds the same shape but reduced. Hook. and Grev. Icon. Fil. t. 21. *a* var. *denudatum,* Jenm.; much smaller and much barer; stipites $1\frac{1}{2}$-3 in. l., fronds 3 - 7 in. l., the fertile a fourth or fifth the size of the barren.

Infrequent on open banks, growing with other herbage, at 2,000 -

3,000 ft. alt.; distinguished by the very dark hair-like deciduous scales that fringe the margins, the midrib on the under side, and petioles. With age the fronds become nearly or quite naked, when, but for their thinner texture they might be mistaken for those of *latifolium*, which in form they nearly exactly resemble, the venation however being rather more open and the apex more inclined to cuspidate. The petioles and rachises vary from stramineous to a bright or dull reddish brown. *a* is a smaller variety a fourth or sixth the size of the type, with very little vestiture and permanent in these characters. It is much the more plentiful, generally gregarious with other herbage.

A Boryanum, Fée, intermediate between *villosum* and *hybridum*, the fronds blunt or truncate, retuse and viviparous at the apex, very open venation, and hairy on the surfaces, likely inhabits Jamaica, but has not yet been recorded.

19. *A. apodum*, Kaulf.—Rootstock short and broad, very densely clothed with light aureous long soft linear scales; stipites tufted, several, $\frac{1}{4}$ - $\frac{1}{2}$ in. l., furnished with a few deciduous spreading hairs; fronds spreading flabellately, 6 - 10 in. l. $\frac{3}{4}$ - $\frac{1}{2}$ in. w., the apex shortly acuminate, gradually tapering from the middle, or upper third, to the base, chartaceous, pellucid; light but rather dullish green, a thin deciduous short fringe of hairs along the margins, other parts naked; veins forked; fertile fronds the same shape, but much smaller.—Hook. and Grev. Icon. t. 99.

Plentiful on open banks and in shade from 2,000 ft. alt. upwards, but chiefly in the middle mountain region; a peculiar and well characterised species. The rootstock forms a flat broad cushion, clothed densely with the bright soft light aureous undulate scales, from which the fronds spring in a loose cluster, and spread flatty in the form of a fan. The stipites are very short, and hardly longer in the fertile than in the barren fronds, both of which in some cases appear as if quite sessile and the vestiture consists only in a short thin marginal fringe, which is deciduous.

20. *A. Cubense*, Mett.—Rootstock short, fibrous, densely coated with aureous lanceolate acuminate crispate scales; stipites contiguous or sub-tufted, $\frac{1}{2}$ - $1\frac{1}{2}$ or 2 in. l., furnished with deciduous spreading rather ferruginous hairs; fronds oblanceolate, spreading 4 - 6 in. l. $1\frac{1}{4}$ - $1\frac{1}{2}$ in. w. shortly pointed or rounded at the apex, the base much tapering and decurrent on the slender petioles, chartaceous densely pellucid dotted, light green, deciduously clothed with scattered hairs, more plentifully on the midrib, a copious aureous fringe to the margins, veins close, 1 - 3 times forked; fertile fronds much smaller, the same shape, but the tapering lower part more elongated.

Infrequent between 2,000 - 5,000 ft. altitude. Allied to *apodum* but distinguished by the smaller rootstocks, shorter, oblanceolate fronds, which are rounded or very shortly pointed in the broad upper part, the base tapering gradually into the slender petioles; by the more copious though deciduous hairs, which, as in the four preceding species, have a beautiful aureous tinge along the margins, and by the closer dichotomously branched veins. The rootstock is at length shortly repent, and in this state the stipites are not so near together. The old fronds become nearly bare, but more or less of the marginal vestiture is retained to the last.

21. *A. spathulatum*, Bory.—Stipites tufted from a small scaly rootstock, very slender, $1\frac{1}{2}$ - 2 in. l., freely clothed with spreading silky yellowish bright hairs; fronds spreading $\frac{1}{2}$ - 2 or 3 in. l. $\frac{1}{4}$ - $\frac{3}{4}$ in. b. oblong or spathulate, the apex rounded, the base cuneate or tapering, soft in early growth, at length firm; pale green, both surfaces freely clothed with silky yellowish hairs, which are fringe-like around the margins; veins forked; fertile fronds on longer stipites, rounded, ovate or elliptical, $\frac{1}{4}$ - $\frac{1}{2}$ in. l. and nearly as w.—Fil. Escot. t. 29. *A. piloselloides*, Presl.

Infrequent on banks and rocks with moss and other herbage over 2,000 ft. altitude. The localities of this species are infrequent, but it is usually plentiful where found. A pretty dimunitive plant, that resembles much, half buried in the moss in which it often grows, a sundew. It is abundantly fertile, and I have never observed it at any season of the year without the soriferous fronds. The small fibrous rootstock is clothed densely with bright-golden silky scales. The fronds are few or several.

22. *A. Lindeni*, Bory.—Rootstock short, densely clothed with darkly ferruginous, crispate, slightly ciliate fine hairlike scales; stipites tufted, very slender, 3 - 5 in. l. freely furnished with spreading ferruginous hairs; fronds pendent, variable in size, the smaller ovate or ovate-oblong, the larger oblong-lanceolate, $1\frac{1}{2}$ - 5 in. l. $\frac{3}{4}$ - $1\frac{1}{4}$ in. w., the apex acute or roundly pointed, the base rounded or cuneate, chartaceous, densely pellucid-dotted, dark green above, paler beneath, more or less ciliate on both sides and with a fringe of ferruginous hairs along the margins, midrib slender: veins open, evident, 1 - $1\frac{1}{4}$ l. apart, simple or forked; fertile fronds on longer stipites, rounded at both ends, elliptical, $\frac{3}{4}$ - $1\frac{1}{2}$ in. l. $\frac{1}{2}$ - $\frac{3}{4}$ in. w.—*A. venustum*, Liebm.

Infrequent on the sides of large rocks and banks in the forest above 7,000 feet altitude, just below the crown of Blue Mountain Peak. Remarkable for its variable fronds and long very slender stipites, open venation, and the dark tan-coloured scales, which on the surfaces of the fronds are to a considerable extent deciduous.

23. *A. siliquoides*, Jenm.—Rootstock short, stoutish, fibrous, densely clothed with silky hairlike yellowish or rather ferruginous scales; stipites tufted, several, rather strong, 2 - 5 in l., freely clothed with long, spreading, aureous hairs; fronds linear-oblong, pendent, $\frac{1}{2}$-1 ft. l. $\frac{5}{8}$ths-$\frac{7}{8}$ths in. w, the apex acute or bluntish, the base tapering, firm, densely pellucid dotted, light green, freely clothed, especially along the somewhat sinuate margins, with silky golden hairs; veins simple and forked, $\frac{3}{4}$ - 1 li. apart; fertile fronds rounded at both ends, ovate or elliptical, $\frac{3}{4}$ - $1\frac{1}{2}$ in. l. $\frac{1}{2}$-1 in. w., stipites longer thickened in the upper part.

Infrequent on open banks and rocks from 2,000 - 5,000 ft. altitude. Distinguished from *villosum* by the narrower, thicker more hairy barren fronds, and difform spoon-shaped fertile ones, which are at first folded together, with close edges, like pods, opening out flat at maturity. It has a peculiar astringent smell when growing. The long silky hairs densely envelope the young fronds. Seen in sunlight, on all parts of the plants, they have a most exquisite golden tinge.

24. *A. villosum*, Swartz—Rootstock short, densely coated with hairliek

dark brown or ferruginous scales ; stipites tufted ; slender, 2-5 in. l., freely clothed with long spreading ferruginous hairs ; fronds pendent, lanceolate-oblong, the apex cuspidate or acuminate, the base cuneate, 4 - 8 in, l, 1 - 1¼ in. b , very thin, pellucid, pale green, thinly clothed on both sides with long spreading hairs, which form a fringe to the rather uneven margins ; veins visible, open, 2½ li. apart, simple and forked ; fertile fronds the same shape, but greatly reduced, the stipites not much if any longer—Pl. Fil. t. 137. Hook and Grev. Icon. t. 95. A. Plumieri, Fée.

Common in damp forests from 2,000 - 5,000 ft. altitude on the sides of rocks ; the commonest and best known mountain species of this group. The substance is very thin and pellucid, in which the veins are conspicuously visible. Unlike the three preceding, the fertile fronds, though much smaller are the same shape as the barren, with a more copious gold-tinted fringe to the margins, and a band beneath free of sporangia, which contributes a very characteristic feature.

25. *A. crinitum,* Linn.—Rootstock short, densely clothed with soft undulated yellowish scales ; stipites tufted 6 - 10 in. l., strong, erect, dark coloured, most abundantly furnished with spreading long blackish hairs ; fronds elliptical or elliptical-oblong, ¾ - 1½ ft. l. 6 - to 9 or 12 in. w., broadly rounded at both ends or the top shortly pointed, fleshy, drying chartaceous, densely pellucid-dotted, very dark green, both surfaces similarly criniferous, the margins freely fringed with long blackish hair, the midrib clothed more abundantly ; veins copiously areolated, areolae elongated, directed to the margins ; fertile fronds much reduced, the same shape, on longer stipites —Pl. Fil. t. 125. Hook and Grev. Icon. t. 1. Fil. Ex. t. 6. Hymenodium, Fée.

Common in places on rocks and banks in very moist forests between 1,000-4,000 ft. alt. A singular, but well known species that has long been among the curiosities of European nurseries. The fronds are as large as dinner table mats, and are the large entire fronds in the American fern flora. The scales of the stipites are ½ in. l., spreading and exceedingly copious. Those scattered on the surfaces drop away in the course of time, leaving them bare.

26. *A. peltatum,* Swartz.—Rootstock very slender, filiform, free-creeping, clothed with bright brown lanceolate scales that are somewhat spreading ; stipites filiform, scattered, paleaceous to the top, or, at length, naked, erect, 1-3½ in. l., fronds flabellate-palmatipartite, ½ - 2 in. diameter, repeatedly dichotomously divided to the axis into numerous spreading linear segments ¼ - ½ li- w., the ends of which are bifid or retuse and the final tips bluntish, firm, dark green, the under surface slightly scaly ; veins forked, simple in the final divisions ; fertile fronds palmate on longer more filiform stipites, reniform, entire or slightly bilobed nearly orbicular, with a thin scariose margin ; veins repeatedly dichotomous. Pl. Fil. t. 50, A. *Rhipidopteris,* Schott.

Infrequent on mossy logs, rocks and banks, in forests on shady moss-grown places from 2,000 - 6,000 ft. alt. The thin wiry scaly rootstock runs freely, throwing up fronds from ½ - 1 inch apart, the fertile being few in number to the sterile. The primary divisions of the sterile fronds are not stronger than the other divisions.

27. *A. sorbifolium,* Linn.—Rootstock thick as a quill, long-creeping,

vertical, ligneous, scaly or barely glabrous; stipites few or many, contiguous or apart, erect-spreading, $\frac{1}{2}$ - $1\frac{1}{4}$ ft l. scaly at the base and often more or less so upwards; fronds pinnate, 1 - $2\frac{1}{4}$ ft. l., $\frac{1}{2}$ - $1\frac{1}{4}$ ft. w., rachis slender, dark-brown, margined or not in the outer part, naked or paleaceous; pinnæ patent, cuneate or rounded at the articulated sessile or stipitate base, acuminate or cuspidate, even, or crenato-serrate-margined plain or striate-surfaced, 5 - 8 in. l., $\frac{1}{2}$ - $1\frac{3}{4}$ in. w., dark green above, beneath paler, chartaceous or membrano-chartaceous, pellucid, glabrous or slightly scaly on the ribs beneath; veins patent, simple or forked, usually close; fertile fronds the same shape but pinnæ greatly narrowed and linear.—Sl. t. 38, Herb. pp. 81 - 83. Pl. Fil. t. 117. *Onoclea* Swartz, *Lomaria*, Klf., *Stenochlæna*, J. Sm. *Lomariopsis*, Fée.

Very abundant in forests, ascending the trunks of trees many yards, from the lowest valleys up to 4,000 or 5,000 ft. alt. It begins growth on the ground, and at this stage the rachis is flatty winged and the pinnae uniformly toothed. The forms are exceedingly numerous, and no very clear line can be drawn between them. Locally there are two states, in one of which the pinnae are numerous (1 - $1\frac{1}{2}$ doz.) the terminal one absent, the rachis ending in a leafless point; in the other the pinnæ are few (6 - 8) much broader and shorter, the terminal one present.

28. *A. osmundaceum*, Hook.—Rootstock strong, ligneous long-creeping, vertical, densely filamentose, brown, scaly; stipites contiguous or apart, scaly at the base like the rootstock, brown $\frac{3}{4}$ - 1 ft. l., fronds subdeltoid, $1\frac{1}{2}$ - 3 ft each way, tri-quadri-pinnatifid, subcoriaceous, naked or the rachis and costal fibrillose beneath; pinnæ petiolate, 1 - $1\frac{1}{4}$ ft. l. 9 - 12 in. w, the larger deeper on the underside; pinnulæ shortly petiolate, lanceolate-acuminate, 3 - 8 in. l. 1 - $2\frac{1}{2}$ in. w., within pinnate, above this pinnatifid, passing through lobes to the fine serrulate point; tertiary segments $\frac{3}{4}$ - $1\frac{1}{4}$ in. l. $2\frac{1}{2}$ - 4 l. w., acute or obtuse, deeper on the upper side at the base, the under rather cut away and plain margined, the inferior ones roundly lobed, the outer serrulate or crenate-entire; veins evident beneath, pinnate in the larger lobes, forked in the smaller; fertile fronds much the same shape, tri-quadri-pinnatifid, ultimate segments soriferous on one or both sides. about 1 li. w. and 2-6 l. l. —Pl. Fil. t 32. Sl. Hist. t. 60, Herb. p. 116, 154, 155. Hook. Gen. t. 78 B. *Polybotrya* H. B. K *P. cylindrica* Kaulf, *P. cyathifolia* Fée. Fil. Ant. t. 2.

Widely dispersed in woods and forests, from sea level to 4,000 ft. alt. ascending the trunks of trees often twenty or thirty feet. The fertile fronds are transient, and are only produced at seasons, so that the plants are generally seen with barren fronds only. The tertiary fertile pinnules are in the larger states sinuate, lobed or pinnatifid.

CONTRIBUTIONS AND ADDITIONS.

Library.

Annals of Botany. March. [Purchased.]
British Trade Journal. April 1. [Editor.]
Chemist & Druggist. Mar. 12-26, April 2. [Editor.]
Garden. Mar. 26, April 2. [Purchased.]
Journal, Board of Agriculture, England. Mar. [Editor.]
Journ. of Botany. Apr. [Purchased.]
Journal, R. Colonial Institute. Apr. [Editor.]
Nature. Mar. 10, 17, 24, 31. [Purchased.]
Pharm. Journal. Mar. 12, 19, 26, April 2. [Editor.]
Sugar. Mar. 15. [Editor.]
Sugar Cane. April [Editor.]
W. I. & Com. Advertiser. Apr. [Editor.]
Sucrerie Indigène et Coloniale. Mar. 15-29. Apr. 5. [Editor.]
Tropenpflanzer. Mar. & Apr. [Editor.]
Bulletin de L'Herbier Boissier. Mar. & Apr. [Conservateur.]
Agr. Ledger. 1897. No. 19. [Govt. Print. Calcutta.]
Ceylon Times. Feb. 23 & Mar 3 & 10. [Editor.]
Report R. Ceylon Bot. Gardens 1897. [Editor.]
Trop. Agriculturist. Mar. [Editor.]
Agr. Gazette, N. S. Wales. Feb. [Dept. of Agr.]
Queensland Agri. Journal, Feby. [Secy. for Agri.]
Sugar Journal Queensland. Feb. 15. [Editor.]
Trans. Acclimatisation Soc. Queensland. Mar 1897. [Secretary.]
Agr. Journ. Cape of Good Hope. Feb. 17 & Mar. 3. [Dep. of Agr.]
Central African Planter. Jan. 15 & 22. [Editor.]
Central African Times. Jan. 29. [Editor.]
Maritius Revue Agricole. Jan. [Editor.]
Journal, Jamaica Agri. Soc. Apr. [Secretary.]
Botanical Gazette. Apr. [Editor.]
American Journ. of Pharmacy. Apr. [Editor.]
Torrey Club, Bulletin. Apr. [Editor.]
Province and Problems of Plant Physiology by Prof. McDougal. Reprint from Science, VII. 168, 1898. [Author.]
Fern Bulletin. Apr. [Editor.]

Publications of the following Agricultural Experiment Stations, U.S.A.:— [Directors.]

Arkansas	New Hampshire
California	New York, Geneva
Kansas	North Dacota
Kentucky	Ohio
Maryland	Oregon
Michigan	South Dacota
Nevada	Tennessee

New Species of Chionaspis & Notes on previously known Species. Reprint, Canadian Entomologist. [Author.]
Report of Agriculture, N. Scotia. 1897. [Secretary.]
Hawaiian Planter's Monthly. Mar. [Editor.]

Plants.

From Botanic Station, British Honduras.

Brassavola nodosa	Oncidium altissimum
Epidendrum (2 spp.)	O. sp.
E. venosum	Schomburgkia tibicinis
Laelia Digbyana	

[Issued 17th Aug, 1898.]

New Series.] MAY, JUNE, & JULY, 1898. Vol. V
Parts 5, 6, 7.

BULLETIN

OF THE

BOTANICAL DEPARTMENT, JAMAICA.

EDITED BY

WILLIAM FAWCETT, B.Sc., F.L.S.

Director of Public Gardens and Plantations.

CONTENTS:

PRICE Ninepence.

A Copy will be supplied free to any Resident in Jamaica, who will send Name and Address to the Director of Public Gardens and Plantations, Kingston P.O.

KINGSTON, JAMAICA:
GOVERNMENT PRINTING OFFICE, 79 DUKE STREET.

1898

JAMAICA.

BULLETIN

OF THE

BOTANICAL DEPARTMENT.

New Series.] MAY, JUNE, JULY, 1898. Vol. V. Parts 5, 6, 7

VINES AND VINE CULTURE.

By Rev. William Griffith.

Read before the Kingston Horticultural Society at the Institute of Jamaica, 21st June, 1898.

The subject of my paper is "*Vines and Vine Culture*". The time at our disposal will not permit of more than a very rapid glance at general principles whilst some attention must be given to those cultural details which are regarded as essentials to success.

Man time out of memory has been a cultivator of the Vine and in one or other of its manifold products it enters very largely into the national, social and religious life of men almost everywhere It is capable of successful cultivation over a wide range of climate and the art of man has devised means whereby in places where otherwise its cultivation would be scarcely possible, grapes of the best quality and in great quantity are regularly produced. The number of recognized varieties in cultivation is very great. A healthy vine in vigorous growth is always a pleasant sight and a well grown cluster of ripened fruit is a "thing of beauty". Grapes vary in size, shape, colour, and flavour very widely, the quality of the fruit however depends neither upon size, nor colour. Some of the smallest alike in bunch and berry, as for instance all the Frontignans, are most delicious grapes, whilst "Buckland's Sweetwater" a much more showy grape very easy to grow, and invariably yielding good crops has absolutely nothing to recommend it except its good looks. The "Muscat of Alexandria" however, which is one of the freest bearers, stands perhaps without a peer for size of both berry and cluster and its invariable high excellence. Vines thrive best near the sea, or rather near the sea level—this is so

here, it is also true in England where I believe most, if not all, the great grape growing establishments are little above sea level. The probable reason may be the more even temperature as between day and night that prevails on the low lands as compared with the hills. During the twelve months of the year the vine can bear very wide divergencies of temperature but a difference of from ten to fifteen degrees is all it can endure with safety as between noon and night. There is also considerable difference in the adaptability of varieties for special localities. Some that are highly prized and largely grown in temperate regions are failures in the tropics and on the other hand kinds that are not regarded as very desirable elsewhere under a change of environment do excellently well here.

Vines can be brought into bearing the second year and as a matter of business it is well known that quantities of grapes are so produced whilst on the other hand with proper care a vine may live and yield annual crops of fruit for centuries.

A vine consists of root stem, branches and canes. The root and stem are the original vine—the branches may be any age from two years and upwards, the cane is the result of the previous season's growth and it is on this cane that all the natural processes of leaf, blossom, tendril and fruit are carried on and completed. It is also on this ripened cane, the produce of the past season, that we rely for the crop of the next season.

You will perceive that the cane I now hold in my hand is jointed—i.e. it consists of nodes and internodes—this formation is peculiar to the green shoot and the ripe cane, and if any portion of this cane is left to form a part of the permanent vine it disappears. On this node or joint all the processes of growth are carried out. On one side we have a leaf —this leaf however you see changes sides every other node and in the axil of the leaf there are two buds, one of which is usually found pushing into growth. This growth is commonly known as the sublateral—the province of this sublateral is to keep the second bud quiet and also to assist in its ultimate development into a plump mature bud capable of giving fruit the following season. To remove this sublateral entirely would be either to start the second bud into growth and so destroy all hope of fruit from it, or else so to reduce its proper amount of sustainance and so render it very doubtful if it could yield fruit. The usual procedure in these circumstances is to follow the middle course and pinch it back to one bud and to keep it so pinched until the season of growth is over; at the time the vine is next pruned it is entirely cut out.

On the other side of the node you may see a cluster of fruit, or a tendril, or the node may be barren. Every node has a leaf; the life-time of which is about nine months—having served its purpose it falls away of itself. Every node however does not necessarily have fruit, or tendril. More than two succeeding clusters or tendrils are never seen together—at least every third node is barren. The tendrils also invariably follow the cluster and never under any circumstance precede it. In Spring after the vine has been pruned and growth has commenced, it is easy to see where the fruit will be—it generally appears after the

third leaf and the first cluster may be followed by another, as a rule a smaller cluster, or by a tendril. Two clusters together are always followed by a barren node and that by either another cluster or a tendril. So soon however as a tendril appears there is no further hope for fruit on that cane. These facts go to prove that cluster and tendril are identical organs and are an illustration of the resourcefulness of natural laws in adapting an organization when no longer needed for one purpose to another very different but equally useful end. The leaves are attached to the node very slightly and may easily be broken off. It is not so with the peduncle of the cluster or the tendril—the fibres in their case run through into the cane and their tensile strength is very great. The influence of the tendrils has a great deal to do with the growth of a young vine. Give it nothing to lay hold upon and so to speak to pull itself up by, and it will sprawl upon the ground and never make a good plant; but put something that it can climb up conveniently near, and you will soon see it reaching out to it and when it once lays hold it will not let go but if exposed to wind will tie a knot and so make itself secure.

It is on this green shoot when developed into ripe cane that the fruit of the following season is to be borne. The more perfectly this process of ripening has been performed, the more sure we are of the coming crop and the better also for the crop itself. Half ripened cane is seldom of much good and growth of over two seasons seldom or ever bears fruit. The point we wish to make here is this:—that it takes two seasons to produce a bunch of grapes—one to grow the fruiting cane and a second to grow the fruit itself— no possible manipulation of the vine can shorten this process. Whether fruit is taken from the cane that bore last season crop or a new cane is grown from the old wood the result is in each case the same. The shoot that has borne fruit once never bears fruit again, and further the cane that might have borne this season but from any cause did not do so never gets another chance. It can at the time of pruning be cut out, or it can be trained in and so become part of the main body of the vine, but it can never give fruit.

You will see from this that one essential condition of successful vine culture is constant careful attention from first to last. Each season the vine has a twofold office to fill, first to carry to maturity its crop of fruit and next to ripen properly the canes for the following year. As a rule a vine that can do either, can do both and to secure these desirable ends over-cropping must be avoided and only sufficient shoots should be allowed to grow as may be required for fruiting cane for the next season and the more you can moderate your demands under both these heads the more likely are you to succeed.

The selection of a site for either a vine or a vineyard is a matter of some importance. In towns as a rule there is little room for choice in the matter. It is indispensable however that sunlight and plenty of air should be secured. Any good garden soil will do fairly well and our natural drainage is generally ample. Where such is not the case it should be provided. Good drainage means good ventilation of the soil, and that means that all the processes essential to fertility are at

work. The soil is warmer, is better supplied with moisture, there is no stagnant water, and root action is rapid and constant. Before the vine is planted the soil should be well broken up to the depth of eighteen to twenty-four inches. The deeper and broader the tillage--the larger the root run, the ampler will be the food supply and the more vigorous your vine.

Some well rotted stable manure, wood ashes, broken bones and lime rubbish added at the time the ground is prepared will be of lasting service. Top dressings of manure in the form of heavy mulching during active growth are very useful. They keep the roots moist and warm and also add to the food supplies. The less the soil is afterwards disturbed the better. Where stable manure is used constantly a light dressing of lime every three or four years will be of benefit. Stable manure forms humus, and humus in the soil adds to its water holding capacity, increases its warmth, helps it to hold elements of plant food and to convert fertilizers into a form assimilable by the plants. A good root run with plenty of food and drink at hand, will not only give you a healthy fruitful vine but will keep it so. Badly nurtured vines are exposed to numberless perils from both insect pests and disease, which healthy vines escape.

I take it for granted that none—now that young plants of good varieties of grapes can be bought for a nominal sum, will lose time and spend labour in raising their own vines from cuttings or eyes. Having everything in readiness when you plant your young vine let the surface of the soil for from 12 to 18 inches round it be about 3 to 4 inches below the surface of the surrounding ground—let the collar of the vine—i.e. where the junction of the new growth is made with the old wood be just beneath the surface of the soil—if possible let no old wood be visible. As the vine makes growth this slight depression will come in useful both as a convenience for mulching and watering as well as keeping the new roots at home. Little by little about an inch at a time the soil can be raised round the vine until it is level with the surrounding surface—into this new soil the vine will send out a multitude of rootlets and the old wood from which the shoot originally grew will gradually perish and you will get what is practically a vine from a bud which is the very best possible.

So soon as root action begins and new growth shows; a slender twiggy stick about five to six feet long should be given it to climb up. Without this artificial aid the vine will show possibly two or three growths—not one of them of any value and it will sprawl all over the ground. On whatever side you insert the stick the vine will find it, lay hold upon it, and then will not be long in finding its way to the top.

By this time there will be developed on the new growth a series of sublaterals. These must be stopped at the first leaf and as new growth shows, be kept stopped. They must not however on any account be taken entirely out—their province is to feed and develop the main growth and if they are removed the cane will probably ripen when little thicker than an ordinary lead pencil whilst if left on, it will be many times stouter. All vine growers are agreed I think as

to the forgoing treatment of the young vine but they are not agreed as to the treatment of the main growth or leader. The general rule is to let it roam at will and sometimes when the vine is vigorous and the treatment liberal a growth of twenty, thirty or more feet may be made during the season.

It has been my practice to restrict both laterals and main growth and I believe it is the right thing to do. I pinch the tip out when a few feet of growth is made and repeat the process once or twice. I find others sometimes do the same.

Mr. A. Young, one of England's best grape growers says "Young canes planted this season must not be allowed to ramble too much; both the leader and sublaterals being kept well in hand" and Mr. Stephen Castle of Bottlesford Vineries, perhaps the greatest authority living on vine culture says "It is a grave error to encourage the wild growth of the leader in young vines." The restrictive method recommended secures a good vine in less time and the general stamina of the vine is improved.

Vines may be trained in a variety of ways and each different way has both its advantages and its advocate. Thousands of vines and tons of grapes are grown annually in pots. Some varieties do exceedingly well in pots and where grapes are wanted and land cannot be had for a permanent arbour this method might often be usefully adopted.

Another method and one that has much to recommend it is the espalier or horizontal trellis. This is a neat, clean, easy method of training which gives a maximum of result for a minimum of labour. Every part of the vine is easily at all times accessible. Every portion of the vine is (except at noon) exposed to the action of light and air. There is also the flat or sloping arbour, the method most generally in use here, and we presume from its universal adoption that it is the method that has been found best adapted to our circumstances. Whatever method of training may be followed the principles that govern the training, pruning and after treatment are the same.
Fruit may be taken from a vine the second year—it is however better not to do so but to wait one or even two years longer by which time the vine should be strong and vigorous enough to yield fruit for many years. Pruning is an intentional and artificial removal of certain portions of the vine to serve one or more of the following ends, viz.:—To give some desired shape to the vine itself either as a matter of taste or of utility, to remove superfluous or ill-placed growth—to concentrate the vital forces of the vine within a limited area—to secure an even distribution of fruit over the different parts of the vine—to open up and keep the canes with foliage and fruit well exposed to the influences of air, light, and warmth, and to secure more and better fruit. You may put a new reading into the old proverb—"Spare the knife and spoil the vine" for "a vine left to itself bringeth its owner to shame."

Many varities, such "Muscat of Alexandria", "Madresfield Court", "Black Hamburgh" and "Fosters Seedling" do best when pruned

back to one eye. Madresfield Court is a magnificient grape and it is a pity that it does not do well with us. A handsomer grape when well grown cannot be found and for quality it is very difficult to beat. Foster Seedling is very fruitful but requires a great deal of care and is only a second class grape when at its best, but where grapes are in demand and earliness with good looks count, it is worth while to grow. Muscat of Alexandria will give good fruit under any method almost. When cut back to one eye the clusters are not large but they are campact handsome and heavier than they look. Pruned to three or four eyes the clusters will be larger, but looser and not by any means so good in appearance.

Vines that lose their first and second leaves early in the season are better pruned to the second or third eye. Young vines pruned to one eye invariably do well, but in the case of old vines—say ten or more years it is better to cut back to a good plump visible bud. Black Barbarosa pruned to one eye is often totally barren Vines should be pruned at the same time every year. By careful treatment and taking the vines in hand early it should be possible to get in time good crops of fruit at any period of the year. Vines may be pruned for fruit any time between January and the end of April. The time when it is best to do so depends upon the variety and the time when ripe fruit is wanted. The same variety pruned in January will not mature a crop as quickly as it would if pruned in March or April The Frontignans take about four months—Muscats five and Gros Colman takes over six months and in dry seasons will keep in good condition on the vines for a month or more longer.

Autumn pruning will give a crop but is seldom satisfactory in either quantity or quality.

In pruning, first cut out all the dead or dying wood. On a well kept vine there ought to be no dead wood. We are speaking now of a vine such as we commonly see, one that receives attention only once a year when half a cart load of worthless growth has to be cut out. Then take out all the thin feeble immature growths that are perpetually showing on the trunk and branches of old vines. You ought then to have nothing left except the ripe canes from which you are to get your crop. These you cut back to the bud from which you desire to take fruit. As a rule except in the instances already mentioned the first bud is the best. It may very likely be almost invisible but if you have a good ripe cane it is there nevertheless As you begin so finish. Apply the same principle to all the canes alike. If you cut some to the first eye and other canes to the second, third or fourth eye because they chance to be plump good looking buds you will have an irregular break. The poorest eyes will push first and from your best wood you may possibly have no break at all. Cut out completely all sublaterals. Leave nothing on the vine except what has a purpose to serve by being there. There is less risk of bleeding when vines are pruned in dry bright weather. I have seldom been troubled by vines bleeding after pruning neither have I noticed any harm to the crop as a result of it. So soon as growth begins, bleeding ceases and when the sap is in motion, as in every case of

bleeding it must be, the new growth soon appears. Between the time when the last fruit is cut to the time of pruning a vine ought not to need much water, all the needful growth by this time should be completed and the ripening of the cane during the fall will be more thorough if the water supply is restricted. Should there be dryness at the roots, a day or so before pruning give the vine a good watering. Never start a vine into growth with dry roots. After pruning and when the new growth has begun the vine must on no account be allowed to go short of water, periodical soakings of water—the warmer the better should be regularly supplied. Too much is better than too little as if the drainage is good the soil will soon put itself right.

So soon as the new growth shows where the fruit will be, disbudding must have attention. By disbudding we mean the rubbing off with the thumb and finger where two or more buds show close together; all except one—the one left being the one in the best position and also removing any buds which if left on would result in over-crowding. The next step is pinching back to the third or fourh leaf all fruit bearing canes and the tying in out of the way of the cluster any non-bearing cane that it may be desirable to retain as a fruit bearer for the following season. Most vines if at all free bearing will show more fruit than they can properly mature. This raises the question as to how many and what clusters should be allowed to remain. Some shoots will show only one cluster—the majority will however be likely to show two and now and again a cane may have three clusters. Here is a case in which two are not better than one, and where three is worse yet. Never leave more than one cluster on one cane and that not always the one that promises to be the larger. Well finished medium sized clusters are worth more than poorly finished larger ones. Nothing is lost by restricting the crop but sometimes a great deal in the way both of weight and quality is gained by it. The crop left on should be distributed over the entire area of the vine as evenly as possible.

After the fruit has set, no time must be lost in the thinning. Free setters such as Frontignan, Foster Seedling, Gros Colman, Royal Ascot and others will be irreparably injured by delay. Muscat of Alexandria, Bowood Muscat and Canon Hall Muscat are shy setters—thinning in their case may be safely delayed a while longer until it is seen what the set is.

Ordinarily it is safe to say that from one third to one half of the berries may safely be cut out but an experienced grower more anxious for quality than quantity would go yet further and take out fully two thirds. In the case of long loose straggling clusters the bottom berries seldom are worth anything—they fail to develope and are slow to ripen— it is best to remove them and so have a shorter but much better looking cluster. Some varieties are heavily shouldered whilst others are destitute of it. At the time of thinning these shoulders should either be carefully tied up or else cut out—to allow them to remain and press upon the body of the cluster will do mischief.

From this time the after treatment should aim at maintaining the vine in vigorous health. Pinching back the sublateral growths on

bearing canes—removing as it shows all superfluous growth which if allowed to remain would tax the resources of the vine needlessly—seeing that the roots are never allowed to become dry—if this once takes place the cane begins to ripen and the growth of the berries ceases—they begin to ripen also but so long as the cane retains its green colour so long both cane and cluster will continue to grow. By these means you may hope not only for grapes the present season but a supply of good cane with a prophesy of better things the season to follow.

Just one word in conclusion as to the varieties that it is desirable to cultivate. Tastes differ and no one variety suits everybody. At the head of the list we must put Muscat of Alexandria and where only one vine can be grown then we say let it be Muscat of Alexandria. The green shoots in young vines are apt to suffer from Black Rot, but about half a pound of powdered Sulphate of Iron (green vitriol) dusted over the earth and raked in will remedy this evil.

As a second vine where more than one can be grown, my choice would be either Royal Ascot, Mrs. Pince's Black Muscat or Madresfield Court, Alicante or *Alnwick Seedling.* These are all black grapes. Royal Ascot is a free bearer—the clusters never turning the scale at over a pound oftener from eight to ten ounces but the grape is very handsome and the quality excellent. Mrs. Pince is a muscat grape having the same flavour as Muscat of Alexandria. It is a free bearer—has done very well with me and is every way a most desirable grape. Madresfield Court I have grown but it is a difficult grape to grow well and I have oftener failed than succeeded. Where room is ample I would however recommend a trial. Success where every one succeeds is much, but to succeed where others fail is more. Alnwick Seedling is handsome, good flavoured, very fruitful and not difficult to grow well—the berry is quite as large as Muscat of Alexandria and is a mid-season or late grape.

Grapes that ripen in the shade are of a superior flavour, take a better colour, look better and keep better, the skin is tenderer and the ripening is more uniform than when exposed to the full light and heat of the sun. Early grapes ripen and take colour better than late grapes. Just as a vine should only have as many clusters as it can mature and perfect thoroughly so also it should only be allowed to have as many canes as it can easily ripen for next season's fruit bearing. Make your demands upon your vine as little exacting as you can, give it kind and generous treatment and it will repay your care abundantly.

SOURCES OF COMMERCIAL INDIA-RUBBER.

By Dr. Morris, C.M.G.

Cantor Lectures. Society of Arts.

Lecture I. delivered April 18th, Summary by the Lecturer.

Since the days when Le Condamine first described the rubber tree of Brazil and Don José, King of Portugal, in 1755 sent several pairs of his royal boots to Para in order that they might be covered with the water-proof "gum-elastic," the use of India-rubber has enormously increased. Besides the demand in almost every department of arts and manufactures the rapid development of cycling and of the use of rubber tyres for carriage wheels has added largely to the increased consumption of this interesting article. The quantity of raw Caoutchouc imported into the United Kingdom in 1830 was only 23 tons. Even in the year of the accession of our Queen it was only about 200 tons. Last year it had increased to 20,000 tons—exactly a hundred fold.

The present value of the imports are about 5 million sterling. The total trade is probably not less than 10 million sterling. More than one-third of the imports is now received from British Possessions. In 1888 only about one-fifth was so received. It is estimated that the world's consumption of rubber is 60,000 tons, of the value of 14 millions sterling. This stupendous quantity of raw material is labouriously extracted from the milky juice of trees and shrubs belonging to three natural orders viz., the Spurges (*Euphorbiaceæ*), the Nettles (*Urticaceæ*) and the Dogbanes (*Apocynaceæ*.) These plants are distributed over nearly every part of the tropical zone—none are found in the temperate zones—the most important being found in the vast basin of the Amazon, an area almost as large as that of the Continent of Europe; others are found on the East and West Coasts of Africa, in Assam and the Malay Archipelago.

Hitherto the preparation of India-rubber has depended upon the crude hereditary art of a semi-savage people, the rubber-hunters, who explore the depths of tropical forests and obtain the rubber milk at the sacrifice of millions of trees, which owing to the recklessness with which they have been treated are yearly decreasing.

The result is that many localities where rubber was once abundantly obtained have almost ceased to produce it. New sources of supply have, it is true, been found in West Africa, especially in Lagos, the Congo State and Portugese south-west Africa. But here also the work of destruction is rapidly going on. The collectors have to go further and further into the interior and the cost of transit is thereby greatly increased. An account was given by the Lecturer of an important discovery whereby rubber could be extracted from the milk in a perfectly pure state. This is a mechanical contrivance on the principle of a cream separator. This was likely to prove of great value in the preparation of Central America and some West-African rubbers where the milk flows in an appreciable quantity and is capable of being brought in by

the collectors. It would be indispensable on regular plantations of rubber-trees. By such means the process of preparing the rubber could be kept under scientific control and all injurious substances such as the proteids and all dirt and chips excluded. The value of rubber so prepared has been shown to be increased fully 25 per cent.

The rubber-trees of Brazil were then exhaustively described, together with the distribution of the various species yielding the Para rubber of commerce. The exports from Para in 1897 including rubber received from Bolivia, Peru and Venezuela amounted to 22,650 tons. Of this amount 51 per cent. was shipped to the United States and 38 per cent. to the United Kingdom leaving only about 11 per cent , or 2,500 tons, for all other countries.

The price of Para rubber which regulates the price of all other sorts has been steadily increasing since 1894 when it was 2s. 11d. per pound ; in 1895 it rose to 3s. 2d. ; in 1896 to 3s. 4d. ; in 1897 to 3s. 6½d. while the average price for the first three months of 1898, was 3s. 9½d. At the last sales on the 15th inst.. it was 3s 11d. per pound.

It was however, pointed out that these prices were below what they were in 1882 and 1883, when fine Para fetched 4s. 4d. per pound.

Concluding Lecture delivered April 25th, 1898.

There is a concensus of opinion that in nearly all localities in Central America the trees of *Castilloa elastica* are being gradually exterminated. Hence the supply of rubber from Mexico, Guatemala, Nicaragua, and the U. S. of Colombia is steadily diminishing. The interesting tree yielding Ceara rubber (*Manihot Glaziovii*) readily propagates itself and its area has not apparently sensibly diminished of late years. The people are, however, being attracted more and more into the rubber districts of the Amazon valley and the amount of Ceara rubber exported is comparatively small.

Mangabeira rubber on the other hand seems to be increasing. The tree *Hancornia speciosa* is found in the States of Pernambuco, Bahia, Rio de Janeiro, and extends westward to Matto-Grosso. The rubber is cured by means of alum, it is of a pinkish colour and the price is generally only one half of that of fine Para. Passing on to the rubber-producing areas of the Old World it was stated that the rapid development of African rubber was one of the most remarkable incidents of recent years. As regards the world's commerce Africa now occupied an important place as a source of India-rubber. The value of the imports of African rubber into the United Kingdom during 1896 amounted to over a million sterling. Of this Foreign Possessions supplied rubber to the value of £206,972 and British Possessions £844,840. Up to within a recent period all the rubber produced in Africa was obtained from climbing plants belonging to the genus *Landolphia*, with sweet-scented flowers and edible pulpy fruits. In 1894 a new rubber tree *Kicksia* was found at Lagos from which in 1895 rubber to the value of nearly £300,000 was exported.

More recently still another new rubber plant (*Carpodinus*) has been

discovered in Africa. This is of a semi-herbaceous character with underground stems which are rasped in water and yield rubber of excellent quality.

The rubbers of Assam, Burma, Penang, and Singapore were then dealt with. Borneo rubber although known since 1798 has only come into commerce within the last fifty years. It is yielded by climbing plants, closely related to the Landolphias of Tropical Africa and is generally of excellent quality.

New Guinea rubber is in part yielded by a species of *Ficus*. The natives are said to allow the sap to run over their arms and body, and when hardened, they remove it and roll it up into balls the size of cricket balls. The prospects of obtaining some of the future supplies of rubber from cultivated trees were favourably regarded. In selecting sites for plantations, preference should be given to localities in which the trees were already found. Para rubber trees introduced to the East at the expense of the Government of India had done remarkably well in Ceylon, Tenasserim, and the Straits Settlements. In Ceylon such trees were estimated to yield 120 lbs of rubber per acre after the tenth year. This would give a probable return of 20 per cent. on the capital invested. In the Straits Settlements the trees were found to yield at an earlier age and the estimated returns per acre were placed as high as 30 per cent. It was stated that where rubber trees were cultivated under suitable conditions they would probably yield a larger quantity of milk than wild trees; also that the rubber from the greater care and attention it would receive would be more uniform in quality and therefore obtain a higher price.

INSECTS IN CIGARS.

Report by ARTHUR G. BUTLER, Assistant Keeper, in charge of the Entomological Department, British Museum of Natural History.

With reference to the letter from Mr. Secretary Chamberlain touching the injury done to cigars in Jamaica by a small boring insect,* it appears that:—

1. The insect is a small beetle allied to the "Death-watch Beetle," although it has incorrectly been called the "cheroot weevil;" its name is Lasioderma testaceum, Duft., and it is known in this country as destructive to ginger, to boot linings, &c. (We found the larva by breaking up one or two of the cigars.)

2. The injury which this insect does to cigars is not confined to Jamaica, but interferes seriously with the exportation of Indian cheroots.

3. Attempts to destroy these insects by subjecting the cheroots to a

* Sent to England by the Director for a report by an expert.

temperature of 80 or 90 degrees of centigrade for a few hours were found to injure the flavour of the tobacco, and therefore it has been suggested that the most likely means of reducing damage would be to keep the leaf during the process of manufacture, as much as possible out of the way of old cheroots and refuse tobacco, and to pack the cheroots in as air-tight a manner as possible, to prevent the beetles getting into the boxes to lay their eggs.

It however seems probable that a more certain way to prevent mischief would be to clean out and thoroughly fumigate the warehouses and manufactories periodically and thus destroy all insect life in these buildings; this could not, of course be done whilst the cigars were in store as the fumigation would doubtless injure their flavour, as steaming undoubtedly would.

ARTHUR G. BUTLER,
25th May, 1898.

REMEDIES AGAINST INSECTS IN GRAIN, PEAS, &c.*

An application has been received for information as to a remedy for weevils infesting red peas, (*Phaseolus nanus*). The weevil was submitted to Mr. Tyler Townsend, Curator at the Jamaica Institute, and was determined as *Bruchus tetricus.*

In the *Kew Bulletin* for July, 1890, there are two methods described as being successfully employed in India in granaries for preventing the ravages of a weevil.

One of these methods is by the employment of carbon disulphide, the other of naphthaline powder.

As the former of these substances, however, is poisonous, inhalation of the vapour finally producing coma; inflammable, its vapour igniting at 301° F. when mixed with air; and explosive when mixed with an amount of air containing three times its volume of oxygen;—it is scarcely so convenient for use as naphthaline powder. This latter substance is cheap, and a very small quantity placed at the bottom of the bin or receptacle in which peas or corn is stored will keep out insects; it can be obtained from druggists.

The following is the plan recommended for applying the powder, if weevils are found in the stored grain.

"It is best to place the naphthaline powder at the bottom of the bin or bulk of grain. To accomplish this, take a bamboo, about 1½ inches

* From Bulletin No. 47, September, 1893.

in diameter, and long enough to reach from the top to the bottom of the bulk of grain. Punch the joints out of the bamboo, so as to be able to pass a stick through from one end of the bomboo to the other. Have the stick made to fit the cavity in the bamboo. Pass the bamboo with the stick in it, down through the bulk of gain from the top to the bottom. Withdraw the stick, and drop into the top of the bamboo about half a teaspoon of naphthaline powder. The bamboo can then be drawn out, as the naphthaline is safe at the bottom of the bulk of grain. If the bulks are large this should be done once to every 10 feet square of the bulk. Repeat the application every 15 or 20 days as the powder evaporates.

"The weevils that can leave the grain will do so, and those that cannot leave are killed by the odour of the naphthaline. I do not believe that naphthaline thus used can cause any injury whatever to grain. For seed purposes the germinating powers appear not to be affected in the least. For marketable grain the colour is not affected, and the odour will leave in a short time if fresh naphthaline is not applied to it. The quantity of powder used is infinitely small in proportion to the quantity of grain, and the powder is entirely destroyed by evaporation, so that for food purposes the effect is *nil*."

COCCIDÆ OR SCALE INSECTS—XIII.

By T. D. A. COCKERELL, Entomologist of the New Mexico Agricultura Experiment Station.

The following species and varieties have been added to the West Indiana fauna since the groups to which they belong were discussed in the present series of Articles.

(12a.) *Margarodes formicarum*, var. *rileyi*, Giard, 1897. (Riley's Ground Pearl.) On the shore at Port Royal are washed up quantities of small pearl-like objects, of a beautiful golden-brown colour. These are the shells of a species of *Margarodes*, which M. Giard has named as above. The same insect has been found in quantity at Largo Key, Florida. by Mr. W. T. Swingle. I am by no means certain that this insect is an inhabitant of Jamaica, as it is well known that seeds from Trinidad can be found in the drift outside of Kingston harbour, and there is no telling whence the *Mangarodes* shells may have floated.

(86.) *Rhizœcus eloti*, Giard, 1897. (Elot's mealy-bug). This is a small mealy-bug, 2 mm. long, which infests the roots of coffee trees in Guadeloupe. It is of a greyish colour, with more or less of the usual cottony secretion. M. Giard's specimens were found by M. Auguste Elot The genus *Rhizœcus* was established by Künckel d'Herculais in 1878 for a species (*R. falcifer*) found on the roots of an Australian palm ; it resembles

Dactylopius, but the female is said to be eyeless, with five-segmented antennæ the last segment of the antenna with sickle shaped hairs, and the tarsi with no digitules.

(87.) *Phenacoccus barberi*, Ckll., 1896. (Barber's mealy-bug). A large mealy-bug discovered by Mr. C. A. Barber in Antigua, on *Allamanda, Thunbergia, etc.* Mr. Barber also found it at St. Kitts, and Mr. Urich found it infesting orange trees in Trinidad. This insect will be known by its comparatively large size (length, not counting the tails, 5 mm.) and the fact that the antennæ have nine joints. It is likely to become quite destructive. In Mexico is found a very closely allied form (*P. yaccæ*), of which *P. barberi* is perhaps only a sub-species.

(88.) *Dactylopius nipæ* Maskell, 1893. (The Nipa mealy-bug). A red mealy-bug of small size, with seven or eight segments to the antennæ and the cottony secretion unusually firm, arranged in distinct tufts. The male is brownish-red. Originally described from specimens found on *Nipa fruticans* in Demerara; since found by Mr. Urich in Trinidad.

(89.) *Dactylopius sacchari,* Ckll., 1895. (The sugar-cane mealy-bug of Trinidad). An olivaceous or pinkish mealy-bug, with seven-segmented antennæ, found under the leaf-axils of sugar-cane in Trinidad. In 1896 Mr. Maskell received specimens of a mealy-bug from Mauritius, on roots of sugar-cane, and on examination they proved to be this same *D. sacchari.*. It seems that the insect has been known to planters for many years in Mauritius, and no doubt it was introduced into Trinidad with sugar-cane from that region.

(90.) *Ortheziola fodiens* Giard, 1897. (The Guadeloupe Ortheziola). A small insect with waxy lamellæ, found with *Rhicæcus eloti* on the roots of coffee trees in Guadeloupe.
The genus *Ortheziola* was established in 1894 by Sulc for a species (*O. Vejdovskyi*) found under leaves and moss in Bohemia, differing from *Orthezia* in having only four segments to the antennæ, and the tibia not separate from the tarsus.

(46a.) *Asterolecanium bambusæ* var. *bambusulæ* Ckll. (The small bamboo fringed-scale.) This is a small variety (female scale 2 mm. long) found on a small species of bamboo in Grenada, by Mr. W. E. Broadway.

(91.) *Pulvinaria broadwayi,* Ckll., 1896. (Broadway's Cottony Scale) A small species easily known by the cottony matter entirely surrounding (but not covering) the scale, and not much projecting behind. The marginal spires are very numerous, and the antennæ are eight-segmented. Found by Mr. Broadway on a cultivated plant not identified in Grenada.

(92.) *Pulvinaria brassiæ,* Ckll. (The Orchid Cottony Scale). A species with a very narrow ovisac, allied to *P. simulans,* found on orchids. It was found on a *Brassia* in a hothouse in Canada, but more recently Mr. Hart has detected it in Trinidad.

(93.) *Ceroplastes euphorbiæ,* Ckll., 1896. (The Euphorbia Wax Scale). A small wax-scale ($3\frac{1}{4}$ mm. long), with the wax not divided into plates, but the plate-nuclei; or knobs very distinct, each on a small dark pink patch. Discovered by Dr. M. Grabham in the Red Hill district, Jamaica, on *Euphorbia hypericifolia.* From it was bred a parasite. which Dr. L. O. described as *Aneristus ceroplastæ.*

(94.) *Ceroplastes confluens,* Ckll. and Tinsley, 1898. (The Confluent Wax Scale). A species found in Jamaica, in which the wax of the several individuals runs together and surounds the twig. A description was sent in 1896 to the Journal of the Institute of Jamaica, but has not yet appeared in print so far as the writer knows.

(95.) *Lecanium batatæ,* Ckll., 1895. (The Sweet Potato Shield Scale) A small (3 mm long), soft, pale ochreous, broad oval scale, found on the tuberous roots of the sweet potato in Antigua by Mr. C. A. Barber. In shape and size it has a general resemblance to *L. terminaliæ.*

(96.) *Lecanium nanum,* Ckll., 1896. (The Dwarf Shield Scale). Very small ($1\frac{1}{2}$ mm. long) flat, reddish-brown or yellowish, broad pyriform in outline. Antennæ seven-segmented. Found associated with an ant (*Azteca chartifex,* Forel) in Trinidad by Mr. J. H. Hart.

(97.) *Lecanium punctatum,* Ckll. 1895. (The Speckled Shield Scale). A small hemispherical scale, $3\frac{1}{2}$ mm. long, ground-colour pale ochreous peppered with brown, but largely excluded by reddish-brown blotches with blackish spots in their centres. Found on *Citrus* in Grenada by Mr. W. E. Broadway.

The following changes in nomenclature should be made :—

(4.) *Dactylopius adonidum,* (Linné) Signoret.
Syn. : *Dactylopius longispinus,* Targ.-Tozz.
Syn. : *Dactylopius longifilis,* Comst.

(6.) *Dactylopius citri* (Risso, 1813) Signoret, 1875.
Syn. : *Dactylopius citri* (Boisd.)
According to Berlese the *Coccus farinosus,* DeGeer, 1778, is the same insect. I have held this doubtful, but if our insect is really identical with DeGeer's, we must call it *Dactylopius farinosus.*

(21.) *Lecanium nigrum* var. *begoniæ* (Douglas).
Syn. : *Leconium begoniæ,* Douglas.

(22.) *Lecanium nigrum* var. *depressum* (Targ.-Tozz) Maskell.
Syn. : *Lecanium depressum,* Targ.-Tozz.

(23.) *Lecanium coffeæ* Walker.
Syn. : *Lecanium hemisphericum,* Targ.-Tozz.

(59.) *Diaspis calyptroides,* Costa, var. *Cacti* (Comst) Maskell.
Syn : *Diaspls cacti,* Comst.

(62.) *Parlatoria proteus* var. *crotonis,* (Ckll.)
Syn. : *Parlatoria pergandii* var. *crotonis,* Ckll.

(71.) *Ischnaspis longirostris* (Sign.)
Syn. : *Mytilaspis longirostris,* Signoret.
Syn. : *Ischnaspis filiformis,* Douglas.

BERMUDA ONIONS IN ANTIGUA.

By Archibald Spooner.

The cultivation of the White Bermuda Onion is gradually being extended here, and in a few years I think will form an important article of export. The secret of success seems to be the choosing of rather poorish clay loam soil containing a fair amount of lime, such as a run-down cane piece, and avoiding any manure, especially artificial manure; on rich land or where manure is used, onions will hardly form bulbs, but all the growth goes to leaves and stem. I have grown onions in Victoria, Australia, where it was always held that heavy manuring was necessary, but here in the tropics the reverse seems the case.

The following hints may be useful. Use only "Bermuda onion seed" either "red" or "white." The seed comes from Teneriffe; neither Spanish, Italian or Madeira onion seed is any use in Antigua, the plants never bulb satisfactorily, but grow either to thick necks or divide up the roots like shallots. The best soil is a rather heavy calcareous loam that crumbles on the top into a fine mould, by the action of sun and rain, and is thus easy to weed. The land must not be too rich, a cane piece from which old ratoons have been cut is quite rich enough without any manure. Of course it must be properly drained. On land of the above description, manure, especially artificial manure like sulphate of ammonia or guano, does harm, the onions nearly all running to top and not to bulb. The seed should be sown in boxes in a good sandy loam, quite shallow not more than a quarter of an inch of soil covering the seed, and special care should be taken to compact the soil round the seed, for which purpose the rows may be pounded with the edge of a brick, the earth may then be watered and kept damp, but not too wet or many of the young plants will die; in seven days most of the seed will be above ground. Never use any manure, especially dung manure, in the seed boxes, the young plants are very liable indeed to be killed by nematode worms and these are always worse in soil enriched with dung. The young onions come up all right, but when about 1½-2 inches high, shrivel up just at the ground level and die. If you cannot get soil free from these pests, put your earth into an oven and bake it before sowing the seed: this is a good plan anyway, as the weed seeds are killed too. Plant the young plants out when about as thick as a slate pencil, about 6 inches apart in the rows, and the rows far enough apart to work a hand hoe between.

The best month for sowing seed here is October, planting out the young plants in November. The onions will be fit to pull about March, when the rains have stopped, and they can ripen up in the dry soil. When the leaves are yellowish, the onions can be pulled up and left on the ground for a few days to harden, then moved to a shaded but windy place and thoroughly dried until the tops are quite brown and can be pulled off without showing a green centre shoot, they will then keep for 2 or 3 months at least, in a cool and airy place, as long as they are not piled up in a heap, or in barrels. Several caterpillars of moths attack the plant here at all stages, especially a black caterpillar; look out for these about a week before new moon, and pick them off.

AGRICULTURE OF THE SUGAR CANE.—I.

Extracts from "Sugar Cane, Vol. I." by Dr. William Stubbs, Director of the Louisiana Sugar Experiment Station.

Edited by Francis Watts, Government Chemist, Jamaica.*

Rainfall.

It is generally estimated that an annual rainfall of about sixty inches is most advantageous for the growth of cane. This amount should be well distributed over at least ninety to one hundred days, of which about forty-five inches should fall during the wet or growing season, and about fifteen inches during the dry. However, annual rainfalls of double this amount occur in parts of Reunion and Guiana where they make large crops of cane; but as remarked elsewhere, such canes are always green and give low sugar contents. On the other hand, cane is grown now most successfully in countries with a very small rainfall by irrigation. Indeed it may be said, that when the temperature and soils are suitable, that cane growing by irrigation is the most remunerative. The largest crops, ripened artificially by the withholding of water, are obtained, and the output of sugar per acre in such countries is enormous. (1)

Cane growing by irrigation has given yields surpassing the highest records of the best sugar countries. The presence of humidity in the air deemed heretofore necessary to successful cane growing, was but a means to prevent evaporation and to maintain moisture, conditions most suitable to the wants of the cane. In irrigated districts, little or no humidity of the air exists.

Drainage.

Nowhere on earth is drainage more essential than in the alluvial districts of Louisiana, and while many plantations may be considered well drained, the average planter has not yet fully appreciated the necessity for multiplying open ditches to the extent of forcing his soils to their fullest capacity. This is evidenced by a trip over the State and observing the varying distances between ditches which obtain in different plantations.

---

* It is thought desirable to present to the readers of the "Bulletin" a series of extracts from a recently published treatise on the Sugar Cane by Dr. Stubbs the well known Director of the Louisiana Experiment Station. This work summarises all the latest information on the subject, and coming from so eminent an authority, the opinions expressed cannot fail to command respect and must prove both interesting and useful to those connected with the sugar industry in any part of the world.

In a few instances the practices recommended hardly apply to the conditions prevailing in Jamaica and the West Indies generally, being based upon the conditions peculiar to Louisiana which has only a semi-tropical climate and a distinct winter period. For the most part however the rules and suggestions laid down are of world-wide application. F. W.

(1) Should there be a revival of the sugar industry in the West Indies the irrigated districts of Jamaica offer great facilities for cane cultivation. With the abundant streams of the island the irrigated areas might be greatly increased.

It is highly important to remember that the mechanical or physical condition of the soil of irrigated districts must be carefully attended to, thorough tillage and thorough drainage must accompany irrigation. F. W.

Only in very dry seasons can badly drained lands be made to yield large crops. Since these unfortunately occur only at long intervals, the average yields on such lands are far below their natural capacity. On badly drained lands neither fertiliser nor cultivation have their full effects, hence the discordant opinions which frequently prevail among our planters, from the use of the same fertiliser or the same method of cultivation. From the experience of this Station it is almost impossible to be "over-drained," provided the work of draining be intelligently performed. It is well for every planter to study his system of drainage, examine his ditches, see if they be deep enough, wide enough and sufficiently abundant to carry off our heaviest rainfalls and retain the "bottom or ground water" at a constant depth below the surface. Excellent results can be obtained with open ditches, provided they are numerous, deep and wide.

In the lower sugar districts these ditches should be at least as close as 100 to 152 feet, and deep enough to hold the bottom water at least three feet below the surface.

The expense and attention annually required for the preservation of open ditches and the loss of land incident to them, together with many other disadvantages would force all of our planters sooner or later to adopt tile drainage, but for the great first cost, and to the absence of fall in the lands by which the tiles can clean themselves.

Irrigation.

The Louisiana sugar planter of to-day is confronted with low prices and unreliable labour, depleted soils and reduced yields. reciprocity treaties and increased imports, monopolistic trusts and monied combinations, prolonged droughts and injurious rainfalls. He must therefore call to his aid every means which will remove the obstacles to maximum crop production. Next to drainage, irrigation is perhaps the most needed factor in the problem of annual large crops. A full crop is rarely obtained oftener than once in five years, and eighty per cent. of the failures are assignable directly to droughts. Irrigation therefore, eliminates the great element of chance from our planting operations, and together with good drainage makes the planter nearly independent of the freaks and idiosyncrasies of the weather.

The results from irrigation of cane have been uniformly successful and satisfactory, sufficiently so to justify the assertion that the profits of irrigation were very large in tonnage and with no sacrifice of the sugar content of the cane.

In establishing irrigation ditches, the reverse of drainage ditches must be observed. In the latter the line of lowest level from the levee to the swamp, is found and followed, while in establishing the main irrigation ditch the backbone, or line of highest elevation, is carefully determined and pursued. This ditch transports the water through the plantation. From this ditch on both sides water may be drawn into the lateral or quarter drains, following still the lines of highest elevation.

From these laterals, water may be drawn into the lowest parts of the field. Our plan in irrigating was to fill the middles of the row nearly full, permitting the water to remain all night and drawing it off in early morning through the drainage ditches. By accident however, it

was found that cane would stand a complete inundation for forty-eight hours, with the water at a temperature of 72 degrees, while the maximum temperature recorded in the station's weather bureau was 90 degrees F. No fears should be entertained of injuring the cane by too much water, for a reasonable time, say two days, in applying it, provided that when it is drained off, it is well and quickly done, in other words, the land is well drained.

Water can easily be drawn from the adjacent river, or bayou, by nearly every sugar planter in the State. The erection of a boiler, pump and syphon will be needed to lift it over the levees. Nowhere, possibly, can a systematic irrigation plant be established and maintained at a less cost than in Louisiana, and our very variable seasons demand it as an adjunct to every plantation that aims to make maximum crops every year.

Sugar Soils.

From what has been already said, those soils which contain the largest fertility, and have a large water-holding capacity, are best adapted to large crops of cane. Requiring so much moisture, the cane, like all the grass family, does best upon clayey or heavy loam soils unless artificially aided by irrigation. Even then the soils must be sufficiently retentive to prevent a too rapid downward percolation of supplied water, or else the profits will be exceeded by the costs of too many irrigations and the washing away of the soluble plant food.

Included in "fertility" is a large amount of humus or vegetable matter which is the controlling factor in determining the amount of fine earth and moisture in a soil. Tropical soils, subject to heavy rainfalls, are almost universally adapted to the growth of sugar cane, since the heavy rains induce a luxuriant growth of vegetation upon such soils, and this vegetation, in its transition into humus, furnishes simultaneously organic acids which decompose the soil particles into very fine earth. Hence such soils, in the course of time, become rich in organic matter and very finely divided earth, the latter supplying the mineral and the former the nitrogenous food, and both (but particularly the humus) retaining that excessive moisture so essential for healthy cane growing. (2) Perhaps the heaviest acre crops of sugar in the world are taken from the soils of the Hawaiian Islands. There are four large islands in this group, whereon sugar is grown in large quantities. Hawaii is a wet island, the cane crop depending wholly upon the natural rainfall. The other three use regular irrigation in the growing of cane. Dr. Walter Maxwell, Director of the Experiment Station at Honolulu, in a recent publication, gives a summary table, shewing the mean of the results in the examination of the soils of the four islands, which are based upon nearly one hundred analyses, which is here given :

(2) At the same time it must not be forgotten that the high temperatures of the tropics lead to rapid decay of organic matter, so that, unless a sufficient amount of vegetable matter be returned to the soil, there is danger of the humus being reduced to so small an amount that the soil becomes unproductive or worn out; obviously this risk is greater in tropical than in temperate climates. but at the same time, the difficulty is more easily overcome owing to the fact that crops to be ploughed in as green dressings can be grown almost all the year round. F. W

Island	Lime per cent.	Potash per cent.	Phos. Acid per cent.	Nitrogen per cent.
Oahu	·380	·342	·207	·176
Kauai	418	309	·187	·227
Maui	·396	·357	·270	·388
Hawaii	·185	·346	·513	·540

With such fertile soils, and with perfect control of the supply of water no wonder that ten tons of sugar have been made per acre.

Soils are only disintegrated rocks mixed with vegetable debris and more or less charged with micro-organisms, through whose agency the food for plants is rendered available. It is not only necessary that an abundance of plant food exhibited by chemical analysis be present, but it must be in an available form. The more finely divided the rock particles, the larger the quantity of available food, the greater the surface areas of its particles, and therefore a large increase in surface tension which gives an increased capacity for holding moisture. Therefore the mechanical condition of a soil is frequently of more importance than a chemical analysis. Formerly a soil was regarded as being a mass of inert matter whose ingredients were rendered soluble by the action of air, water and chemicals. This view has given way to a knowledge recently gained by scientific investigations, that all fertile soils are swarming with microscopic organisms which are essential to the proper elaboration of the food materials in a soil for plant use

Hence a thorough investigation of a soil involves a chemical analysis, a mechanical separation of its particles, a study of its physical properties, and a microscopic research for its bacterial content. ([3])

A chemical analysis will give its contents of silica, iron, alumina, lime, magnesia, potash, soda; phosphoric, sulphuric and carbonic acids; chlorine, nitrogen, etc, The total quantities of each of the above soluble in the selected solvent are given, but no definite methods has yet been devised by which a knowledge of the immediate availability of these ingredients may be obtained. Chemical analysis has, however, a high value in the hands of a trained chemist.

The particles of soils vary greatly in size as well as in constitution, and a knowledge of the mechanical formation of a soil frequently throws a flood of light upon its relation to heat and moisture, as well as suggestions upon its cultivation. It has been conventionally agreed that all particles in a soil between 1 and 2 mm* in diameter shall be called fine gravel; between ·5 and 1 mm coarse sand; between ·25 and ·5 mm., medium sand; between .1 and .25 mm., fine sand; between .05 and .1 mm., very fine sand, between .01 and .05 silt between .005 and .01 mm., fine silt and .0001 and .005 mm., clay. Such an analysis describes the textures of a soil and determines the crop which should be grown thereon, by comparing the water-carrying capacity of the soil with the water requirements of the crop. To illustrate, the more clayey the soil, the greater its carrying capacity, and the nearer the approach to pure sand, the more droughty it becomes. Grasses, in which sugar cane may be placed as a gigantic specimen, require at least 25 per cent of moisture continually in the soil for best

(3) A recognition of these points is essential if scientific and progressive agriculture is to prevail. F.W.

* Note—mm., millimetre = .0393 of an inch.

results, a condition found frequently in clayey bottoms; while some vegetables, as melons, do best on soils carrying only 4 per cent of water and hence find congenial environments in our climate on very sandy soils.

Other crops grown in this latitude require intermediate quantities between these two extremes.

It may be remarked, on the other hand, that very large quantities of clay or sand are often equally objectionable, giving excesses of moisture or dryness, both being detrimental to the welfare of bacteria, which are necessary to soil fertility.

The conditions necessary for bacteriological existence in our soils are the presence of air and water, a favourable temperature, an absence of light, the presence of proper chemicals, and inoculation with the bacteria desired.

The bacteria best known, and in which we are mostly interested, are those taking part in nitrification, and are of three distinct types or genera: 1. Those which convert nitrogenous matter into ammonia. 2. Those which convert ammonia into nitrous acid. 3. Those which convert nitrous acid into nitric acid. Each are necessary to the complete transformation of nitrogenous matter in the soil to nitric acid, the form of nitrogen chiefly available as plant food. Since nitrogen is the most costly ingredient of our fertilisers, estimated at present to be worth 15 cents per pound, it is evident that the farmer or planter should endeavour to maintain such conditions in his fields most favourable to these ferments, and thus enhance his harvests by drawing upon his soils rather than upon purchased fertilisers.

With these preliminary remarks, let us examine several typical soils of each of the sections of the sugar belt The following are given from hundreds of analyses made in the laboratories of the stations, and are selected because they represent typical soils and have also been subjected to mechanical analyses, which are given further on. These soils represent the alluvial soils of the upper and lower positions of the cane belt of the Mississippi river, the brown loam and whitish soils of the bluff formation, and the sugar lands of the Red river deposits.

Table No. 1.

Chemical Analyses of Soils.

Locality.	Insoluble Matter.	Potash.	Soda.	Lime.	Magnesia.	Iron and Alumina.	Phos. Acid.	Sulph. Acid.	Organic Matters.	Nitrogen.
Evan Hall Plant. cwt. 9 ...	88.720	.092	.158	.394	.087	1.12	.068	.028	2.96	.097
" " " 26 ...	83.510	.170	.173	.272	.047	6.620	.137	.038	4.45	.118
" " " 31 ...	[illegible]0.800	.133	.143	.545	.044	5.041	.103	.038	...	...
" " " 37 ...	83.680	.162	.142	.313	.025	6.33	.126	.046	4.10	.130
" " " 44 ...	83.710	.125	.184	.182	.036	5.68	.075	.139	3.91	.120
" " " 52 ...	79.210	.112	.111	.434	...	6.99	.075	.037	3.51	.117
Home Place ...	86.516	.233	.081	1.494	.039	6.822	.095	.043	1.90	.060
" " ...	86.420	.206	.122	2.376	.052	5.256	.092	.031	3.33	.084
Sugar Exp. Sta., dark soil ...	62.550	.747	.1 1	.910	1.361	13.444	.146	...	6.65	.085
" " light " ...	70.102	.414	.021	.787	.814	11.28	.161	019	3.16	.112
State Exp. Sta., Baton Rouge, bluff soil ...	90.650	.100	.078	.170	.114	4.225	.064	.036	3.15	.096
Subsoil of same ...	89.79	.164	.054	.163	.160	6.510	.128	.025	2.74	.074
Ditto, white soil ...	87.72	.120	.076	.060	.121	6.67	.112	.021	2.82	.080
Subsoil of same ...	83.00	.180	.123	.120	.085	8.80	.106	.016	4.21	.105

An inspection of the above and many other similar soils would lead to the conclusion that the contents of valuable ingredients in the average soils of the sugar belt would be about as follows:—Lime .5, potash .4, phosphoric acid .1, and nitrogen .1 per cent. In an acre to the depth of 12 inches, estimated to weigh 5,000,000 pounds, there would be 25,000 pounds lime, 20,000 pounds potash, and 5,000 pounds each of phosphoric acid and nitrogen. An average cane crop of 25 tons including tops and fodder, will contain about the following: —Lime 20 pounds, potash 60 pounds, phosphoric acid 35 pounds, and nitrogen 75 pounds. Hence there is lime enough for 1,250 crops of cane, potash for 333, phosphoric acid for 150 and nitrogen for 70.

There is, therefore, no deficiency of plant food in our average sugar soil, and the aim of every planter should be to extract yearly the maximum amounts, which can be obtained only with proper drainage, supply of water (irrigation) in summer, and proper preparation and cultivation of the soil.

Table No. 2 gives the mechanical analysis of the soils whose chemical analyses have been given. Additional soils characteristic of many localities are also given.

TABLE NO. 2.

Mechanical Analyses of Soils

Locality.	Fine Gravel 2–1 mm.	Coarse sand 1–.5 mm.	Medium sand .5–.25 mm.	Fine sand .25–.1 mm.	Very fine sand .1–.05 mm.	Silt .01–.1 mm	Fine silt. .01–.005 mm	Clay .005–.0001 mm	Heated at 110.	Loss on ignition.
Evan Hall cwt. No. 9 ...	0.00	0.11	0.14	0.64	47.28	25.66	4.88	13.40	4.96	2.96
" " No. 26 ...	0.00	0.19	0.34	0.76	22.40	39.88	8.30	19.28	4.42	4.45
" " No. 37 ...	0.00	0.11	0.23	1.39	33.05	23.58	8.14	24.40	5.00	4.10
" " No. 44 ...	0.00	0.09	0.28	1.00	22.15	25.93	9.12	31.25	6.27	3.91
" " No. 52 ...	0.00	0.08	0.28	0.58	23.55	37.73	7.51	22.44	4.32	3.51
Andubon Park (dark soil) ...	0.082	0.064	0.11	0.62	11.49	19.54	14.94	41.29	6.69	6.50
" " (light soil) ...	0.00	0.055	0.11	0.71	26.22	34.99	6.95	22.28	4.00	4.64
" " plat VI. A. ...	0.00	0.084	0.58	0.36	37.82	28.04	6.83	20.64	3.30	3.49
" " plat VIII. D. ...	0.00	0.070	0.18	0.78	4.72	19.16	12.68	47.00	7.78	5.61
Home Place (front) ...	0.00	0.06	0.07	0.22	61.43	26.37	2.08	6.65	1.56	1.90
" " (back) ...	0.00	0.05	0.06	0.21	36.41	42.78	4.26	9.06	2.34	3.33
State Exp. Station (bluff soil) ..	0.01	1.08	0.40	0.55	21.65	55.44	9.45	10.90	0.98	1.58
" " " (subsoil) ..	0.05	0.14	0.31	0.37	15.75	47.28	9.33	21.12	2.41	2.17
" " " (white soil) ...	0.00	0.09	0.50	0.71	19.99	55.52	8.78	9.74	1.38	2.29
" " " (subsoil) ...	0.31	0.26	0.31	0.43	17.82	48.69	9.50	17.21	2.58	2.62

From table No. 2 it will be seen that very few of these soils can properly be called sandy. They are loamy silts or silty clays. Their water capacity is great, requiring special attention to drainage in order to reduce it to the amount most favourable to soil ferments. The clayey content of several suggests the propriety of breaking at exactly the right time—neither too wet nor too dry—throwing it into ridges to relieve it of excessive moisture and providing for escape of flood waters.

The red river soils, particularly the front lands, are largely composed of very fine sand, with small portions of clay, while the bluffs and prairie soils are mainly silt.

Numerous experiments have been made at the Sugar Experiment

Station during the past two years to determine the rate of nitrification on the different soils and at different depths, and on soils variously treated.

In every instance nitrification was most abundant at a depth of three to four inches, decreasing in depth until at two feet it was practically naught. In lands in good tilth, or manured with stable manure broadcast, or with a good growth of cow peas, nitrification was rapid and copious. It was more abundant on the ridge of the rows than in the middles. Drainage could almost be measured by the rate of nitrification. In badly drained soils it was almost entirely absent, while high dry ridges gave abundant evidence of the activity of the microbes. An immersion of the soil for a few hours, by a heavy downpour of rain, suspended for two days the process of nitrification. It was more abundant in soils lightly stirred than in those cultivated with the plough.

Soils stirred daily gave increased quantities of nitrogen over those stirred weekly, and more in the latter than in those stirred bi-weekly.

In fact, good drainage and frequent surface cultivations were prime factors in rapid nitrification.

Preparation of Soil.

With this knowledge of our soils we can now proceed to apply the well-established principles of preparation of all crops.

Since these soils are so strongly silty and clayey, and being level, are without natural drainage, it is manifest that they should be placed in a condition of artificial drainage, to insure warmth and necessary conditions of bacterial growth. Every operation should look to the maintenance of these conditions. Hence flat culture is unsuccessful. They should be broken as deeply as possible to admit air to assist in drying out excessive water, and most important, to give as large an area as possible for the foraging of the roots of the cane, since experiments have shown that in stiff lands but few roots pass beyond the broken soil. They should be broken as early in the fall as possible, thrown into high ridges and the middles, quarter-drains and ditches well cleaned out, for the quick removal of winter rains.

The spring should find each row in the condition of an ash bank, and the planter should endeavour to keep it so by proper cultivation throughout the season.

We break land to prevent the natural tendency of all soils to return to rocks, evidenced frequently in the hardpan just beyond the plow. We break land to destroy weeds and grasses and relieve the soil of foulness, preparatory to the growth and sustenance of the cultivated crop.

We break land to control moisture, throwing up in high ridges to relieve excessive moisture and flushing or ploughing flat to conserve the winter's rainfall for the summer's crop, on dry soils. If the work of preparation has been properly done, in accordance with the nature of the soil and the demands of climate, subsequent planting and cultivation are simple processes.

If, however, our work has been imperfectly performed then subsequent cultivation must be directed to the acquirement of tilth, which is simply obtaining the best conditions for the growth of crops.

Tilth, however. should always be obtained, if possible before planting

and then cultivation would simply be a maintenance of tilth. Unfortunately such a happy condition does not always prevail. From haste, overcropping, bad weather, carelessness, and sometimes from ignorance, furrows are hastily thrown together, seed planted in cloddy soil, ditches shallow and foul. The poor stands thus obtained are cultivated more with a view of getting land in good tilth than to benefit the plant. Again, the crop, after it has reached the age when rapid and shallow culture should be practised, is, from causes given above, left to contest with grasses and weeds the soil designed solely for it; or perhaps unfavourable seasons may keep away ploughs until weeds and grass have taken possession of the land Then come the turn ploughs and hoes, and by heroic efforts they are buried or removed. In either event, the results are the same, the crop has not been improved by such treatment.

Plan Pursued by Our Planters.

The plan usually pursued by our best sugar planters is as follows: Corn planted early and laid by early, and at lay-by sown in cow peas at the rate of one to three bushels per acre. The corn is gathered early and the vines turned under in August or September, with four to eight mule ploughs. The lands are thrown into beds or rows from 5 to 7 feet wide, the middles are broken out with double mould-board ploughs, the quarter-drains are cleaned to a depth of six inches below middles of the rows, the ditches are maintained at the proper depth. The rows are opened, the cane is planted and covered.

If every detail has been properly attended to, the soil in the rows will be maintained throughout our winters in a condition favourable to nitrification and growth. No water should at any time cover the rows even for a short while, and the drainage should be such that none should ever accumulate either in the middle or quarter drains.

The above plan, if rigidly followed, leaves but little room for improvement in the preparation of our soils for cane. (4) If the subsequent cultivation of the crop was as skilfully and scientifically performed, our acre yields would be greater and our money returns more satisfactory. The fundamental principles underlying successful agriculture everywhere may be expressed in the following: A thorough preparation of the soil, proper fertilisation and shallow and rapid cultivation.

Varieties of Cane.

Chapter X of Dr. Stubbs' Treatise deals with the subject of varieties. After alluding to the sources from which the various canes have been collected the writer says:—

These importations, together with collections of those varieties imported prior to 1885, make up the "garden of sugar cane varieties," which has been cultivated for several years with the hope that some variety would be found which would be better adapted to our wants than those now cultivated in our State. Up to date our results have not been satisfactory. Cane is a plant which yields slowly to its environments. It requires a long time and considerable patience to acclimate it. The inherited characteristics of tropical tendencies so unsuitable to our short seasons, are but slowly modified by cultivation in our climate. There is,

(4.) The introduction of systematic rotation of crops, and the regular use of green dressings with leguminous crops appears very desirable in Jamaica, and throughout the West Indies. F. W.

however, a slow but gradual change in nearly every variety with each year's cultivation, and a few promise hope of ultimate benefit to our industry. But the acclimation of old varieties, with the view of obtaining those best suited to our wants, has been entirely superseded by the introduction of seedlings.

After describing their attempt to obtain seedlings from their own seed, he says:—

In 1893, just as we were recovering from sore disappointment in our failure to secure either plants from seed or seed from plants, the station received from the Royal Agricultural Society of British Guiana, twenty-one of the most promising of the new seedlings originating at Barbados.

The seedlings from cane seed vary very greatly in almost every respect, size, colour, sugar content, habits of growth, etc. Out of 500 young seedlings, perhaps only a very limited number will prove, upon investigation, worthy of further propagation. This property of variation common to nearly all plants, is excessively great in sugar cane, and hope was entertained that through this property and by careful selection a cane may ultimately be obtained which will be rich in sugar and at the same time give a large tonnage—the goal of every sugar planter's ambition. For the first time in the history of our cane culture such an opportunity is presented through this property of variation of seedlings. Heretofore any marked change in varieties came from accidental bud variation, which occurred at rare intervals and were often lost by virtue of the absence of a trained and intelligent eye to detect and utilise it. By selecting at maturity from a large number of seedlings those plants whose vigour, size, and sugar content, or some other desirable property, were peculiarly marked, and propagating them, over 500 new varieties of cane have thus been introduced. From this large number further selection is being made annually, and those superior to the rest have been generously distributed throughout the sugar world in order to test them under varying conditions. Should concurrent testimony be obtained from many sources, the cane will be named and largely propagated.

The nomenclature of the varieties of cane is execrable. No sooner is a cane received in a country than it is given a local name, either that of the introducer, or the country from which it was directly imported. This is especially true in this State, where we have the Otaheite cane, the Japanese cane, the Palfrey cane, the La Pice cane, etc. The canes introduced and thus named are frequently identical with those known in other countries by old and well established names. Frequently importers ignore old names and the countries from which they come and call them by some descriptive property, more frequently colour, *e.g.*, green, yellow, yellow-striped, red ribbon, etc. Several of the consuls in sending canes to the station, mentioned only local names or colour and omitted entirely the history of the canes sent. Ever since the reception of this large number of varieties, the station has been making earnest and persistent efforts to establish the identity of many of its varieties with the prominent ones of old sugar countries, as well as seeking the original home of each one, but so far very little success has been attained. It is difficult to compare canes and eliminate individual differences even when grown on the same soil and under the same conditions. It is therefore almost impossible to decide identities in varieties when grown under such dia-

metrically opposite circumstances as exist in Louisiana and a tropical island, *e.g.*, Cuba. There is, however, a growing demand on the part of those scientifically cultivating cane, to have all this confusion of names eliminated, and a movement is on foot looking to a solution of this perplexing problem. It can only be done by interchanging freely all the known varieties and have them all cultivated under exactly the same environments. Could this be done at all of the botanical gardens and experiment stations within the sugar districts, it would not only afford numerous comparisons of the same varieties under varied conditions, but, would throw perhaps a flood of light upon the important question of differentation under changed environments of the numerous varieties under test.

This station has accordingly, after consultation with those similarly interested in other countries, sent samples of all its varieties to Hawaii, Australia, and Demerara, with a view of comparing them with the varieties of those countries and establishing synonymous canes It will also gladly exchange with any botanical garden or experiment station, the numerous varieties under cultivation here.

By an adoption of the above suggestion, it is believed that in a few years valuable information to general cane culture would be obtained. ([5])

Composition of Cane.

Analyses show that every ton of cane delivered at the mill removes from the soil 9.4 pounds albuminoids, or 1.5 pounds nitrogen, and 12 2 pounds of ash. This ash would contain 2.17 pounds potash, 1.48 pounds phosphoric acid, and .8 pounds of lime. In Louisiana the proportion of tops and leaves to canes is about one to three, Therefore

---

(5) A study of the varieties of the sugar cane is of paramount importance, for by careful selection canes may be obtained suitable for cultivation under various conditions of soil and climate. Equally important is a knowledge of the behaviour of different varieties in relation to fungoid diseases.

Many of the West Indian Islands have suffered most severe loss in recent years from fungoid parasites in their canes. In some of these islands it has been demonstrated that there is a marked difference in the manner in which the varieties are attacked. This question has formed the subject of investigations in Barbados and Antigua, where it has been shown that while some varieties readily succumb to fungoid attack, others are remarkably resistant. Whether this immunity will be maintained in spite of the constant exposure to infection, consequent upon the fact of their being propagated in infected fields, remains to be seen. So far, however, the selection of varieties would appear to constitute the most effective method of combating fungoid attacks: by growing the most hardy varieties, rejecting these as soon as it appears that they show signs of breaking down and substituting others, attacks of such fungi as *Trichospheria sacchari*, the rind fungus, may perhaps be overcome.

So far Jamaica appears to have escaped any serious fungoid attack of its sugar canes This is possibly due to the fact that several varieties are cultivated, while at the same time there are but few Bourbon canes amongst them. It will be well for Jamaica planters to be on the alert to check any outbreak should such occur, and this check will probably be best secured by an immediate change of the variety of cane under cultivation. As a preventive measure it is very desirable that a careful study of as many useful varieties as can be collected should be made at the Botanic Stations, these experiments will serve a double purpose by first leading to a knowledge of the saccharine richness and yield of the different varieties and secondly a knowledge of their freedom from or liability to fungoid and other parasites. An attempt is now being made to study this subject in a more systematic manner and it is hoped that in a short time there may be presented to planters information compiled from local experiments bearing upon this important side of the sugar question.—F. W.

every three tons of mill canes will give one ton of tops and leaves. One ton of tops and leaves will remove 35.80 pounds of albuminoids, or 5.7 pounds nitrogen, and 68.8 pounds ash. Since every ton of cane has about one-third of a ton of tops and leaves, there will be required for the growth of a ton of cane, exclusive of roots, and including tops and leaves, 21.3 pounds of albuminoids, or 3.4 pounds nitrogen, and 34 pounds ash. When the cane is harvested. the trash (tops and leaves) is left on the ground and usually burnt. In burning, the ash or mineral matter is restored to the soil, but the nitrogen is dissipated into the air. Therefore, to one burning his trash, there is withdrawn from the soil with every ton of cane 3.4 pounds nitrogen, 2.17 pounds potash, 1.48 pounds phosphoric acid and .8 pounds of lime. There is a saving of 1.9 pounds nitrogen, by burying the trash, to each ton of cane made, equal to the nitrogen in 27 pounds of cotton seed meal. From the above, it will be seen that the quantities of elements usually supplied in commercial fertilisers are assimilated and utilised by the cane in relatively small quantities when compared with other staple crops. The excessive weight, however, of a crop of cane grown on a given area causes the total absolute quantities of the ingredients referred to, to more nearly approximate those removed from the soil by other plants.

Forty tons of cane per acre is not unusual. This amount would require 136 pounds of nitrogen if the trash was burnt, or 60 pounds if trash was turned under, 87 pounds potash, and 59 pounds phosphoric acid.

The above quantities of nitrogen would be represented by 1943 and 856 pounds cotton seed meal

It would require over 700 pounds kainit to supply the potash and nearly 400 pounds of a 15 per cent. acid phosphate to furnish the phosphoric acid, if none were furnished by the soil.

Burning of Cane Trash.

Shall we then burn our trash or shall it be turned over? Chemically there is a loss of nitrogen for each ton of cane harvested, by burning, equivalent to that contained in 27 pounds of cotton seed meal. On a field averaging 30, 20 or 10 tons per acre, there will thus be lost an equivalent of nitrogen contained in 710, 540 and 270 pounds cotton seed meal—a loss which would be serious in any other agricultural industry. Why then do we burn? The following reasons are given :—The cane borer, which at times becomes so abundant as to seriously injure the cane, is practically held in check by burning the tops in the trash, which contain the worms, thus destroying thousands annually. If a cessation of planting cane on the part of every planter in the State could be simultaneously practised for one year, and no cane saved for seed wherein the worms could hibernate, and all the trash everywhere burned, it is believed the borer would be exterminated in Louisiana. Since it is extremely rare that any are found in the stubble left after cutting down the stalks, and if by chance any should be so found, the cold of our average winters and the heat from the burning trash would destroy them.

Again, our stubbles are liable to be killed during our winters. It has been clearly demonstrated that this danger is greatly enhanced by excessive moisture, and the latter is frequently produced during our winters, if the trash as permitted to remain on the ground or turned under with a plow. Burning trash off the stubble immediately after

the cane is harvested, leaves the cane rows clear of vegetable matter and enables them to shed freely the water falling upon them, and if proper drainage has been established, the entire field will remain practically dry during our wettest winters and the stubble will rarely be injured even by excessive cold. Experiments in burning the trash off immediately after harvest have so conclusively demonstrated the wisdom of the act, that almost every planter in the States seizes the first dry spell after his cane is cut to fire all his fields. If the trash be left on the ground it will absorb and retain a large amount of moisture in the spring and thus retard the sprouting of the stubbles. Burnt fields always give earlier stubble stands.

Leaving the trash on the field is also a great obstacle to the proper cultivation of the ensuing stubble crop. A crop of thirty tons of cane will leave ten tons of a light porous trash, which during the winter and spring will absorb large quantities of water, and which, decomposing very slowly, will prevent the successful running of ploughs and cultivators. It is claimed by observant managers that the increase in the stubble crop, due to a more excellent cultivation rendered possible by burning the trash, will alone more than compensate for the fertilising ingredients lost in burning. These are the main reasons for burning, and an experience of twelve years enables the writer to pronounce them sound and valid. The loss of vegetable matter by burning, is willingly, knowingly, but rigidly sustained to prevent subsequent losses of a far more serious nature. (6)

Variation in composition of different parts of the Stalk

Canes vary in composition, not only with age, in different countries and on different soils, and under different climatic conditions on the same soils in the same country, but also among themselves. Individual stalks rarely ever give exactly the same composition. This will be more fully discussed under the chapter on "suckers," when it will be shown that in harvesting a clump of canes, no two will be found

---

(6) Burning the Trash — The question whether trash should be burned or no has been most keenly debated. Dr. Stubbs gives excellent reasons for pursuing this practice under the conditions prevailing in Louisiana where it would appear the gains far outweigh the losses. It seems quite open to question whether under the conditions prevailing in Jamaica the gains would equal the losses. Some observers maintain that comparatively little check is givento the ordinary moth borer (*Diatræa saccharalis*) by burning the trash tops. In Louisiana with its winter it is highly desirable to prevent the chilling which would result from leaving a water soaked layer of trash covering a field during a winter, when the temperature for brief intervals may fall as low as freezing point. This difficulty does not confront the Jamaica planter, who for the most part will find his trash of value as a covering to his fields, a covering which will conserve moisture and prevent the injurious action of the direct heat of the tropical sun upon his soil or his young plants.

Again not only does burning involve the loss of the Nitrogen contained in the trash, but it involves also the loss of the organic matter which by decay forms humus, a substance of great value in soils, beneficiently modifying the relation of the soil towards water, rendering stiff close soils more easily drained and worked and causing light sandy soils to retain moisture more efficiently. From this point of view, under tropical conditions, burning probably entails considerable loss, particularly if carried on systematically year after year. It is admittedly true that a heavy covering of trash is in some degree troublesome when ploughing the fields, but this difficulty has been overcome by the methods in vogue amongst West Indian planters.- F. W.

of exactly the same age, and therefore variable in composition.

Even individual canes have not the same composition throughout their length. It is well known to every planter that the butt of a cane is the sweetest part of the stalk, and that its sweetness decreases as you ascend, until finally the extreme upper part is almost devoid of sugar.

So apparent is this fact to the taste, that chemical analysis is not needed to convince even the "small boy" who chews the cane. Yet time and again has the chemist verified this fact by analysis. He has shown that the sucrose is most abundant in the lower portion of the cane with a minimum of glucose. That the former decreases and the latter increases as you ascend the stalk, until finally in the upper white joints the glucose absolutely predominates. This suggests the wisdom, when only sugar is desired, of lowering the knives in the field and removing the immature upper joints, which from their composition are bound to be melasegenic in the sugar house and perhaps restrain from crystalization otherwise available sugar. Again the nodes and internodes of a stalk of cane vary in composition even when taken from the same part of the stalk. The following analysis of the nodes and internodes of twenty stalks of purple canes with normal eyes, will show the variation:

	Brix.	Sucrose.	Glucose.	Solids not sugar.	Fibre.
Nodes	15.94	12.6	0.13	3.21	16.5
Internodes	17.4	15.5	0.94	.96	8.00

The nodes vary from the internodes, not only in the total nitrogen content, but also in the form of nitrogen present. The nodes containing .1829 per cent. of total nitrogen, of which .1778 is albuminoids, and .005 amides; while the internodes have only .0817 per cent. of total nitrogen, of which .0559 are albuminoids, and 0258 amides. It will thus be seen that the nodes carry much larger amounts of solids not sugar, fibre and nitrogenous matters, while the internodes are richer in sucrose and glucose. This explains why the juices from the different mills in our sugar houses vary in composition, and that the juice from the first mill is purer and more easily worked than that from the other mills. The first mill extracts juice mainly from the internodes, which are softer than the nodes. The second and third mills crush the nodes and extract from them the impurities given above, and the more powerful the expression, the more impure the juices obtained. Attached to every node is an eye or a bud, destined to become a future plant. Around this eye is stored the food for its future use, and in this respect the nodes resemble the seeds of flowering plants with the sucrose and glucose of the internodes as a further food reserve.

The excess of gums, mucilages, albuminoids and fibre in the node, is therefore intended as food material for the young plant until it shall become large enough to obtain its own food, and these substances are

formed in the node during the process of ripening by the condensation of the simple molecules into more complex and less soluble forms of gums and mucilages, and by the union of amides and glucoses in the presence of sulphur compounds, to form albuminoids. As the bud develops, the albuminoids are converted into soluble amides and glucoses, and the gums, mucilages and fibre, into soluble carbohydrates (glucose or dextrose), which furnish the food for the young plant until it can draw its own sustenance from the soil. In case this storehouse should be exhausted before the plant is capable of self-support, it can draw on the reservoir of sucrose, glucose or nitrogenous matter stored in the internodes, as shown by the experiment of Prof. Ross. The action of ferments during germination will readily produce the above transformations and may even convert a part of the fibre into soluble carbohydrates, thus rendering a portion of this substance available for plant food. The following is the conclusion of a series of investigations made by Dr. J. L. Beeson in the laboratory of this Station.

"To recapitulate: It has been found in the course of this investigation tnat the juice of the nodes of the cane is quite different from that of the internodes, containing markedly less reducing sugars, more "solids not sugars," and more alluminoids bodies; that the "fibre" of the nodes contains more albuminoids, more insoluble carbohydrates not sugar, which readily pass into reducing sugars; that as the cane deteriorates, reducing sugars are formed more rapidly in the nodes than in the internodes. In our opinion these facts can be best explained by the hypothesis previously stated, namely that the physiological function of the node in the cane is similar to that of the seeds in the case of flowering plants—to store food in the region of the eye for the use of the young plant before it has taken sufficient hold of the earth to draw sustenance from the atmosphere and soil. The hypothesis is further confirmed by the fact that the isolated nodes of the cane when planted will germinate and grow to maturity.

"As already shown, there is a marked difference in the purity co-efficient of the juices from the nodes and internodes. That from the nodes gives an average of 81 per cent. purity, while that from the internode an average of 89 per cent. approximo. If a machine could be devised by which the nodes could be separated from the internodes so as to work the juices separately, it would doubtless be profitable. Since the nodes in the samples analysed constituted about 14 to 16 per cent, of the whole weight of the cane, it would be a great loss to throw them away. Since the nodes show a much lower purity co-efficient, many short joints on the stalk decrease the purity of the juice of the whole cane."

PREPARATION OF LAND, PLANTING, ETC.

Once in three years a restorative crop is interjected between the cane crops. The rotation being as follows:—First year, plant cane, second year, stubble cane, third year, corn and cow peas. No system of rotation is complete without a leguminous crop, and among the leguminous crops the cow pea occupies the front rank as a rapid soil restorer, frequently accumulating in a few months over 100 pounds nitrogen per acre. An examination of the roots of the cow pea vine

during rapid growth will reveal large quantities of wart-like tubercles which when crushed and a portion examined under the microscope will reveal countless thousands of bacteria, peculiar to this plant living in symbiotic union with its host. Nothing can supplant the cow pea in the short rotation adopted by the sugar planter. Cow peas perform many valuable functions. By their deep roots and immense foliage they pump up from great depths and evaporate large quantities of water, and thus placing the soil in a condition relative to moisture most favourable to nitrification. They intensely shade the ground, thus protecting the nitrogen ferments from the destructive influences of direct sunlight, and enabling them to work directly up th the surface. Their tap roots are pumping, along with water, soluble plant food from great depths.

But the chief virtue lies in its extraordinary power of utilising the free nitrogen of the air. Therefore, it is used once in three years to restore the nitrogen exhausted by two crops of cane.

Sometimes second year stubble is carried, and then the pea crop is every fourth year. A few planters practice a continuous growing of cane, and in doing so plant pease in the old stubble and cut the latter early for seed cane, and bury the pea vines for the coming plant cane.

A crop of corn is planted, and when it reaches the height of a few feet, it is laid by and simultaneously sown with cow pease, using one to three bushels per acre, of the Clay, Unknown or Black varieties. Early in summer the corn is gathered and sometimes the pea vines made into hay for the stock of the plantations. In either event, the soil, with or without the pea vines, is turned under with four, six or eight horse plow in August or early in September, and the cane planted in October.

Ordinarily, the root residues of the pea vines give enough nitrogen for the ensuing plant cane, and many planters positively assert on this account that it makes no difference to future crops whether they are removed or turned under, but carefully conducted experiments on this station show that when turned under there was an average increase of 7.42 tons of cane per acre, extending through plant and stubble, over soil treated similarly, with vines removed for hay. Yet where there is stock to be fed, it is wise to utilise the vines as hay and restore the manure from the stables to the soil.

Up to date the work of inverting the corn stalks and pea vines has been performed by large turning ploughs with steel discs, for cutting the vines, attached in front. These ploughs are difficult to handle and frequently get choked, making the operation a slow, tedious and expensive one. Recently the disc ploughs have been placed on the market, and one of them has been successfully used by the station for such work.

It has on our soil buried successfully pea vines that were waist high and very thick, ploughing to the depth of ten inches and cutting a furrow 15 inches wide. It was drawn by three heavy mules and showed on the dynamometer a pull of 500 to 550 pounds. It was managed entirely by one hand who rode on the plough. There was no choking and no stopping to clean the plough. Nearly three acres per day can be ploughed with this implement. For flushing land it has no equal, and the draught is much lighter than with the four-horse plough

usually used, and the work performed more satisfactory, there being no compression of the soil at the bottom of the plough, caused by the shear and landside of the turn-plough.

After the land is flushed, it should be bedded with two-horse ploughs into high rows, five to seven feet wide and the middles carefully ploughed out. The quarter-drains should also be cleaned. It is thus ready for planting late in September or early in October, the time at which fall planting is done. When ready to plant, the rows are open with a double mould board plough and two or more running stalks are deposited in this open-furrow and covered by a disc cultivator, plough, or by hoes. Fall planted cane is always covered deeper than that planted in the spring, in order to protect it against the cold of our winters. The open furrow in which the cane is deposited should be above the level of the middles between the rows, and the latter should be at least six inches above the bottoms of the quarter drains. Thus planted and maintained during the winter, there will be no trouble from either excessive cold or moisture. (7)

---

(7) The method of working here recommended is one which may be advantageouslyfollowed in Jamaica; the intervention of a leguminous crop to be turned in as a green dressing is wise provision, as is fully explained ; in these islands not only will the cow pea serve this purpose, though perhaps it will prove as useful as any other, but the Gungo, No Eye Pea, or Pigeon Pea (*Cajanus indicus*) and Woolly Pyroe (*Phaseolus Mungo*) and Bengal bean (*Dolichos Lablab*) are also employed to advantage, indeed it may be safely asserted that the success with which the cultivation of sugar was carried on, until recent years, in the Colony of St. Kitts was largely due to the wise manner in which the Gungo Pea or Pigeon Pea was employed for green dressing.

The element of plant food which is most completely removed from the soil by the cultivation and manufacture of sugar is nitrogen, which is also the most expensive ingredient of artificial manures or fertilisers, this element is largely restored by a judicious system of green dressing with leguminous crops. The practice is by no means a new one, it was known and followed by the Romans, and Virgil refers to it in his Georgics. Of late years a great impetus has been given to the practice of green dressing by means of leguminous crops owing to the discovery of the manner in which they assimilate atmospheric nitrogen and thus accumulate it in the soil for the use of subsequent crops. Not only do green dressings add to the store of nitrogen in the soil, but they improve the physical condition and texture of the soil in a marvellous manner, aiding the draining of stiff clays, and increasing the water holding power of light, sandy soils. In addition to this the use of a green dressing does much to assist in keeping down grass and troublesome weeds. There are very few soils that will not be materially improved by the use of green dressing.

The planting of a corn crop a little before the cow peas or other plant used for green dressing, as suggested by Dr. Stubbs, is an obvious advantage; by this means corn for the use of the stock is obtained while the trailing stems of the leguminous plants finding some support, tend to form a denser thicker mass thus increasing the amount of vegetable matter to be ultimately ploughed in.

This use of green dressing commends itself not only to those who cultivate sugar cane, but will prove of the greatest use in the cultivation of Bananas, Cocoa, Coffee, Limes, Oranges, while in growing ginger, it will probably prove an adjunct of the first importance as maintaining the necessary fertility of the soil and at the same time adding to the store of humus and nitrogen.

The use of a fertiliser containing Potash and Phosphates (without nitrogen) will often result in a great increase in the growth of the leguminous crop and it would seem desirable to add those ingredients of the artificial manure to the leguminous crop rather than to raise the green dressing and then apply the Potash and Phosphates to the plant canes.—F. W.

THE PRINCIPAL DISEASES OF CITRUS FRUITS IN FLORIDA.

By Walter T. Swingle and Hedbert J. Webber.

Reprinted from Bulletin No. 8 of U. S. Department of Agriculture Division of Vegetable Physiology and Pathology.

Introduction.

It is the purpose of this bulletin, to give in as brief and concise a manner as possible, an account of some of the principal diseases of citrus fruits, especially those occuring in Florida. The following are the diseases which we will endeavour to describe: Blight, die-back or exanthema, scab or verrucosis, sooty mould, foot root or mal-di-gomma, and melanose.

The diseases of citrus fruits have received more or less attention from the Department, through the Division of Vegetable Physiology and Pathology, since the year 1886. In 1891 Prof. L. M. Underwood was sent to Florida to make a preliminary study of this subject. Later the same year one of the writers, with Dr. Erwin F. Smith, was sent to Florida to carry on further studies, especially on blight, and the following spring the former returned to continue the work. In the fall of 1892 a slightly increased appropriation enabled the Department to station both writers regularly in Florida. A laboratory especially erected for the purpose was donated by the citizens of Eustis, Fla., and this point was made our headquarters. Since the completion of the building both laboratory and field investigations have been carried on continuously, with highly gratifying results. Melanose, an entirely new disease, has been studied and remedies for it discovered. Satisr factory remedies or preventives have also been found for all the othee diseases mentioned above, foot rot being the only one which could b- said to be under control when the work was commenced. Much information has been collected in relation to the causes of the various diseases and their effects on the plants attacked.

BLIGHT.

This disease, also called wilt and leaf curl, is found only in Florida, and so far as known at present is incurable. Nearly all citrus fruits are liable to it, but in different digrees. Trees grown on light hammock soil are most susceptible, but no locality in the State is entirely exempt. The malady has been known for at least twenty and possibly twenty-five years. The first reliable account of it, however was published in 1891 (1) by Prof. L. M. Underwood.

Blight never attacks trees until they have attained considerable size and have begun to bear fruit. In any given grove usually only a small per cent of new cases occur each year, but the fact that the disease is apparently incurable and that it attacks the oldest and most vigorous

(1) Journal of Mycology, Vol. VII, pp. 32–34.

and fruitful trees in the grove renders it one of the most destructive maladies known. It is widely distributed over the State occurring in the oldest and best groves and on the land best suited for profitable orange culture. The affected trees do not die at once, but apparently revive when the rainy season commences. In this way false hopes are aroused and the owner waits for years before he finally removes the blighted trees and replaces them with healthy ones. Much time and money have been wasted on supposed cures, the worthlessness of which does not become apparent until after several years' trial. In some localities from 1 to 10 per cent of the trees blight annually. The annual loss resulting from this disease in Florida is from one to two hundred thousand dollars. Within the last ten years it has caused losses probably amounting to several million dollars.

Symptoms.—Blight usually appears very suddenly and on trees that have previously seemed perfectly healthy. The first symptom is a wilting of the foliage, as if the tree was suffering from drought. At first the wilting is slight and can be plainly seen only on hot, dry days; but it soon becomes very pronounced, and often continue so during the wet season in summer, when rains are almost a daily occurrence. Most cases of blight appear in early spring, from February to April, which is usually a dry season. Sometimes, however cases occur in midsummer, when the ground is thoroughly wetted every few days. After the wilting becomes severe the foliage begins to drop, and in a few weeks to a few months, according to the severity of the case, the affected branches shed nearly all their leaves. In many cases the whole top of the tree is attacked at one time, but very often only a single branch shows the disease at first. In such cases, however, the entire tree soon becomes affected.

As soon as the rainy season begins the trunk of the larger branches put forth numerous water sprouts, which grow rapidly and at first seem to be perfectly healthy. Eventually, however, these sicken and gradually die back. The branches which first show the blight usually retain for a year or more some foliage, which is abnormally small and of a dingy green colour. New growth is very sparse and does not produce normal-sized leaves. Such branches often show green twig all over, even when nearly leafless. In the spring following the first wilting (unless it occurs late in winter, when it is not until the second spring following) these branches, though often nearly leafless, flower very profusely and continue blooming for ten days to three weeks after the normal period of flowering has passed. Unlike the lemon the flowering season of the orange is very definite, and usually is not longer than two weeks. This profuse and late bloom consists of small flowers which almost never set fruit. In fact, very little fruit is produced by a tree after it is attacked by blight. Trees bearing a full crop may sometimes be attacked late in summer and mature their fruit, but it is only in case of late attacks that any considerable amount of fruit can be seen on diseased trees. Fruit borne by blighted trees is usually undersized, but otherwise is apparently normal.

The contrast in the amount of fruit produced by trees attacked by blight and those affected with mal-di-gomma is very striking, trees suffering from the latter disease often bearing an unusually heavy crop.

In very severe cases of blight the trees succumb so suddenly that the leaves do not fall, but simply wither and turn brown on the twigs. This is also frequently the case with a single branch. In such cases the trees usually die outright in a few weeks and never put out any new growth from the trunk. Again, a single branch may wither as suddenly. In the great majority of cases, however, a vigorous new growth pushes out from the trunk at the beginning of the rainy season and at first it would seem as though the tree would recover. Sometimes such sprouts continue growing vigorously two years or more, but sooner or later they show small and usually yellowish leaves and begin to decline. Often, too, such shoots wilt and show all the symptoms of a fresh case of blight. Ordinarily the tree continues to decline gradually and is finally removed before it dies, to make place for a new tree. Again, cases may linger ten years or more, making a slow sickly growth, and even bearing a little fruit. Cases of real recovery from genuine blight are, however, almost entirely unknown, although hundreds of growers have been deceived by the vigorous growth of water sprouts sent out by blighted trees after the first wilting.

A most remarkable fact is that the roots of blighted trees invariably seem to be entirely healthy. The vigorous growth of water sprouts they support shows that they are capable of considerable functional activity.

No anatomical features which are characteristic of blight have yet been found. Under the highest powers of the microscope the tissue of every organ of blighted trees appears to be normal, which is in striking contrast to foot root and die-back. The physiological activity of the leaves and branches, however is very much deranged, as has been proved by experiments on the loss of water from blighted twigs.

Varieties of trees attacked.—Almost all citrus fruits are attacked by blight, although some sorts are nearly exempt. Common oranges (*Citrus Aurantium*), tangerines and mandarins (*Citrus nobilis*), and grape fruit (*Citrus decumana*), in about the order named, are the most susceptible. Lemons blight less than any of the fruits mentioned, while limes and sour oranges, especially the latter, are almost exempt from this disease. Certainly not more than one sour orange tree in a thousand is blighted even in regions most liable to the malady. Curiously enough, the sort of stock used appears to have no influence in increasing or diminishing the susceptibility of trees to the disease. Common oranges budded on sour orange roots are apparently as liable to blight as are sweet seedling trees.

Situations most liable to the disease.—Although blight attacks citrus fruits growing on all kinds of soil, it is most common on trees growing on very light, sandy hammock (1). Such soils are usually composed almost wholly of sand with an admixture of decaying vegetable matter; sometimes, however, they are underlaid at a depth of from 4 to 12 feet with clay or hardpan (sandstone). Trees growing on clayey

(1) Hammock land is that which was originally covered with hard woods, especially live oak, magnolia, hickory, etc.

hammock or high pine land (1) are almost exempt from the disease. On flatwood land (2) the trees are less susceptible than those on light hammock, but more susceptible than those on high pine lands.

As the blight is most prevalent on the best orange lands, with the exception of clayey hammock, which is rare, it is obviously impracticable to prevent the disease by planting on lands least subject to it.

Cause—So far the most diligent search, both in the field and in the laboratory, has failed to reveal the cause of blight. Judging from what is known of the disease, it is not improbable that it is caused by some minute parasitic organism, but the character of the soil to a large extent governs the entrance and spread of the organism. In many respects blight strongly resembles peach yellows, the exact cause of which is also unknown. Certain it is that blight cannot be attributed directly to cold, drought, wet weather, close proximity of hardpan, or improper fertilisers, as is often erroneously believed.

Is blight contagious?—As before stated, this malady in many respects resembles peach yellows, which latter disease is contagious by budding as has been proved by experiments. Numerous experiments are under way to determine whether blight can be introduced by buds on the roots or tops of trees, but so far no conclusive results have been obtained. The disease attacks trees in groups, as is obvious in groves where it exists. A year or two after a tree is blighted it is a common thing to see the adjacent trees show the blight on the limbs next to the diseased tree. All these circumstances strengthen the belief that the disease is of a contagious nature.

Preventiv Measures—Experience has taught that it is not only useless but dangerous to attempt to cure blighted trees, since it is probable that the disease is contagious, and that a diseased tree left in the grove may infect surrounding healthy trees. It is by all means the safest and at the same time the most profitable plan to dig up and burn all blighted trees as soon as they appear and plant new trees in their places. In many instances it would seem that prompt destruction of trees as soon as attacked has decidedly reduced the number of new cases as compared with adjoining groves similar in all respects, but where the diseased trees were allowed to remain. In peach yellows the prompt extirpation of cases as they appear is the only known way of preventing the spread of the disease.

In replanting, good-sized trees are preferable to small trees, as the latter are liable to be overshadowed and starved out by the large trees surrounding them. The diseased trees when dug out can be either hauled away and burned, or better cut up and burned on the spot, thus avoiding any possibility of spreading the disease through the grove. It has been abundantly proved that trees planted where blighted ones have stood are not more likely to contract the malady than any other in the vicinity, and in no case are they liable to blight before they begin to bear.

---

(1) Land covered with scattering *Pinus palustris* and a few trees of *Quercus cinerea and* Q. *catesbœi*, all growing so for apart as to allow grass to grow so thick that it is burned off annually, thus preventing the growth of underbush.

(2) Much like high pine land, but low and flat, with a subsoil near the surface and more undergrowth, composed largely of shrub palmetto (*Serenoa serrulata*) and Ericaceæ.

The practice here recommended of extirpating all cases as they appear is now largely followed by those who have had the most experience with blight and who know the uselessness of supposed remedial treatments. In all badly infected regions concerted action is highly desirable, but even if this cannot be secured the grower should not be deterred from eradicating the diseased trees from his own grove. Aside from the fact that such a course probably lessens the spread of the malady, it is the cheapest and best policy.

DIE-BACK OR EXANTHEMA.(1)

The disease of the orange and other citrus fruits, commonly known as die-back, is widely distributed throughout the orange region of Florida but is not known to occur in any other part of the world. The name "die-back" originated from the behaviour of trees affected, a few inches of the vigorous new growth die back in early spring. The disease is not much feared by growers, because it is apparently not contagious; but while the damage it causes in a single grove may be slight, the total loss, on account of its very widespread occurrence, is nearly as great as that resulting from any other disease affecting the orange. The malady is well known to most orange growers, but is generally poorly understood. It was first accurately described by J. H. Fowler(2) in 1875. When and where it first appeared has not yet been determined Growers have known of its occurrence for years, presumably ever since orange culture became common in the State.

The damage caused by die-back is much greater than is usually estimated. Many groves have suffered for years from slight attacks of the disease, the damage being caused mainly by the excessive dropping of the fruit and by the coarseness and staining of that which remains on the trees. In some severe cases due to improper fertilisation and cultivation, groves have been badly injured and almost the entire crop of fruit lost. Frequently much loss is incurred by planting trees on improper soils and continuing to cultivate and fertilise them for years after they contract the disease. Almost every grove in the State has a few cases of this disease. Trees growing in the vicinity of stables, chicken houses, privies, etc. are the ones generally affected, and also those growing on the margins of lakes, or on low, wet, poorly drained soils.

The diminished productiveness of trees badly affected with die-back, together with the splitting and falling of much of the fruit and the disfigurement and coarseness of that which does develop, makes such trees almost worthless. The malady causes great loss of fruit, renders more of poor quality, frequently permanently stunts the tree and eventually kills it. The annual loss resulting from die-back in Florida may be conservatively estimated at about $100,000.

---

(1) From the Greek, meaning an eruption or pustule.

(2) Fowler J. H., On the Die-back in Orange Trees (Proceedings of the Florida Fruit Growers' Association, annual meeting January, 1875; reprinted: Florida, its Scenery, Climate, and History, Sydney Lanier, 1876, J. B. Lippincott & Co., Philadelphia, Appendix, pp. 281–290).

Symptoms.—Die-back has probably more characteristic symptoms than any known plant disease, principally among which are the following:

1. The ends of the very rapid growing shoots turn yellowish before maturing, and finally become stained reddish brown in patches or throughout. This appearance is caused by a deposit in the outer cells of a reddish-brown resin-like substance. This yellowing and staining of the twigs, which is very general on the new growth all over the tree, is followed by the dying back of the affected twigs for a short distance, usually 3 to 6 inches. The reddish stain may occur on the twigs back of the point to which they die, and, indeed, may spread in irregular patches, more or less over the entire new growth.

2. On the new growth (most frequently at the nodes, but sometimes in the internodes) there occur comparatively large swellings, caused by gum pockets formed in the wood. These pockets frequently become quite marked.

3. Eruptions, caused by the bursting of the bark, very commonly occur on new and old twigs. In such cases the tissue swells up, protrudes from the rupture, and becomes stained by the reddish-brown, resin-like exudation, which is so characteristic of the disease. These eruptions are very numerous, and in badly affected trees many limbs, from an inch in diameter down to the smallest, become thickly studded with them. This character almost invariably accompanies the disease and is present at all seasons of the year, so that it may probably be regarded as the principal symptom. Trees may be slightly affected, however, and not show this symptom.

4. In diseased trees rapidly grown young shoots often droop in a characteristic manner. After starting to push, the twigs gradually bend downwards and the ends turn up a little, giving the twigs a slightly S shaped curve. This however, is not always a symptom of die-back, being occasionally seen in perfectly healthy trees.

5. Young twigs frequently develop an abnormal number of buds in the axils of the leaves, where, under normal conditions, only one or two are formed. This over production of buds is often followed by a gummy exudation at these points. Several of these buds from one node may develop into branches, which in connection with the short internodes, freqnently give the new growth a somewhat fascicled appearance. This causes a dense foliage and after the new growth which produces this fascicled appearance, has died back the tree takes on a very regular appearance, as if it were clipped. This is very characteristic of cases in the middle stage of the disease. In a later stage large limbs die back, leaving around the trunk a dense growthof small water sprouts with large leaves. These shoots in turn become stained with the characteristic reddish-brown exudations and eruptions and finally die back. In this stage of the disease, which is one of the last, the tree presents a very ragged appearance, many of the large limbs being dead.

6. The leaves on trees affected with die-back are rather larger and generally longer and more pointed than those on healthy trees. This symptom, however, is not very noticeable.

7. The foliage of diseased trees is always a very dark green; indeed this colour, so much desired by some growers, indicates that the grove is on the verge of showing the disease.

8. Frenching or spotting of the leaves with white and green frequently occurs in the more advanced stages of the trouble, but can hardly be considered a symptom.

9. Slightly swollen, stained spots often occur on leaves of trees in a medium stage of the disease. Any slight mechanical injury or injury due to the attacks of the six-spotted mite (red spider), which works in definite spots, is liable to be followed by a swelling of the leaves at the points injured, accompanied by the characteristic stains, thus forming brown, swollen spots. These spots are evidently formed only in places where the leaves are injured.

10. The fruits of diseased trees early assume a pale, sickly green colour, which is quite different from the dark-green colour of normal fruits. Some fruits split and fall while in this condition, but by no means as many as fall in the next stage of the disease.

11. When the fruits reach a size of from 1 to 1½ inches in dimeter they gradually change colour, turning light lemon yellow and commonly showing a slight brown exudation in places on the rind. At this stage many fruits fall; this usually occurs after the appearance of the brown stains, but sometimes before. On trees slightly affected many of the fruits fall early, while on trees badly affected it is seldom thet any fruits remain on the tree until they reach full size. The fruits usually split before dropping. At first a slight crack appears around the eye end or apex of the orange, accompanied by a slight gummy exudation. Finally a large split opens across the fruit, exposing the segments and causing the orange to rot and fall.

12. Both the fruits which fall early and those which come to full maturity are usually more or less disfigured by irregular brown stains, similar to those occurring on the twigs. These stains frequently cover a large portion of the fruit, rendering it unsalable.

13. Slight swellings are sometimes found on the rind, particularly in the sour orange. These swellings are caused by gum pockets formed within the tissue of the rind. Very frequently a formation of gum also occurs in the segments immediately around the axis, generally near the seeds.

14. The fruit of trees affected with die-back usually ripens considerably earlier than that of adjoining healthy trees of the same variety. As a rule, however, it is large, very coarse, thick skinned, and disfigured with brown stains, and in consequence often unsalable.

15. The roots of trees affected with the disease usually have a healthy appearance, but in severe cases, on improper soils, they frequently become ulcerated and die back for some distance, the dead ends rotting away. Roots which have died back frequently have large and somewhat swollen ends, from which later on a number of small roots frequently arise.

The order in which the symptoms appear and their severity vary greatly, but generally are as follows: The first sign of the disease is the unusually dark-green colour of the foliage, rank growth, and large, thick-skinned fruit. These symptoms are soon followed by the staining and dying back of a few twigs, and by brown stains formed on some of the fruits. The fruits developed are very prone to split and drop prematurely. In the first stage of the disease either the stained fruit or the stained, dying twigs must be present to determine with cer-

tainty the presence of the malady. Trees affected with the disease may grow for years and show only one of these characters; in other cases all the symptoms may be present, but to a very slight extent, so that careful search must be made to find them. As the disease progresses, the brown staining of the fruit and twigs becomes more abundant and the dying back of the twigs occurs all over the tree; eruptions form on the young and old twigs; nodal swellings, due to the gum pockets, become very abundant; and the tree assumes the dense foliage and regular outline described above. In this stage of the disease many fruits set, but they usually turn yellow, become stained, split, and fall before maturity, only a few, if any, reaching full size. Soon the gum eruptions extend to the old limbs and these die back. The rank new growth becomes limited to the centre of the tree; here branches grow luxuriantly for a time, only to become stained and die back later. The tree then assumes the ragged appearance described above. In this stage no fruits set, and, indeed, the tree has become so sick that no flowers are formed. This disease is not accompanied by profuse blooming, as is the case in blight; on the contrary, the tendency is to produce very little bloom. If the disease is allowed to continue unchecked the trees will ultimately cease to grow and finally die.

Cause.—The cause of the die-back is not yet thoroughly understood. For several years experiments have been under way to determine whether various fertilisers may not produce the malady. Experiments have also been conducted in the laboratory with water cultures. In these experiments various forms of pure chemical manures were employed, the amounts used being under absolute control. From the results of these experiments and from extensive field observations in many parts of the State it seems highly probable that the disease is caused by malnutrition. In most cases it is probably induced by excessive use of organic nitrogenous fertilisers. As before stated, trees near stables, chicken houses, privies, etc., are very commonly affected by the disease. Heavy applications of cotton-seed meal, dried blood, or other highly nitrogenous organic fertilisers are frequently followed by the appearance of the trouble. Groves fertilised continuously with organic fertilisers rich in nitrogen are usually more or less affected with the malady, depending upon the quantity of fertiliser used. Whether the chemical manures, such as nitrate of soda or sulphate of ammonia, when used in excessive quantities, will finally produce the disease, is yet questionable, but all evidence indicates that they will not. In several experiments the excessive quantities of chemical manures used killed the trees outright, although no signs of the disease appeared.

A form of the disease known as soil die-back is very common and is very evidently independent of the action of any fertiliser. Certain fields of limited area, which are low and poorly drained or underlaid with "hardpan" (a ferruginous sandstone), seem predisposed to produce the disease. Trees set out on such soils never develop normally, but contract die-back in its worst form. These frequently remain for years in a stunted condition, each year's growth as formed dying back. Such trees finally die if allowed to remain untreated. Often considerable loss is incurred by planting and fertilising groves on the die-back soils. The symptoms of die-back are the same whether due to

excessive fertilisation or to improper soil conditions, and it is probable that the real cause will be found to be the same in both cases. Both forms of the disease appear to be greatly aggravated by excessive cultivation, which apparently destroys the surface roots and forces the tree to feed lower down.

Treatment.—When die-back is due to the excessive use of highly nitrogenous organic fertilisers, an effective remedy consists in simply ceasing to cultivate and allowing all weeds to grow. In fertilising, omit entirely all highly nitrogenous organic manures, but use about the normal quantity of potash and phosphoric acid. As the tree recovers a small amount of nitrogen should be given, preferably in the form of nitrate of soda or sulphate of ammonia, until the tree is brought up to its normal condition. If the disease is produced by the close proximity of privies, chicken houses, barns, etc., removing these will usually result in the recovery of the affected trees. In the case of barns which can not be removed it has been found effective in some cases to dig trenches between the trees and the barn to prevent the feeding roots from running under the former. Of course the caution in regard to the use of organic nitrogenous fertilizers given above is applicable in this case also. When the malady is caused by planting on die-back lands, treatments vary according to the character of the soil. If the grove is on low, wet soil, through drainage will usually be found an effective remedy without other treatment If the soil is underlaid with hardpan, mulching the trees with pine straw, oak leaves, or something of this nature, and stopping cultivation will allow the feeding roots to develop near the surface and usually bring about a cure. The latter has been found an effective treatment in many instances. Good drainage is also beneficial in such cases.

SCAB OR VERRUCOSIS OF THE LEMON AND OTHER CITRUS FRUITS.

The introduction of this disease into the United States is comparatively recent. It first appeared in Florida about the year 1884 and spread rapidly over the State and to Louisiana. Although many thousands of trees affected with scab have been sent to California, it seems that the disease is unable to exist there permanently. The reason for this will appear later. The malady also occurs in Australia and Japan, from which latter country it was undoubtedly introduced into America. So far it is not known to occur in Europe or Africa. The first account of the disease was published by F. Lamson-Scribner in October, 1886 (Bulletin of the Torrey Botanical Club, New York, Vol. XIII, No. 10, pp. 181-183), at which time Professor Scribner was Chief of the Section of Vegetable Pathology of the Department of Agriculture. A fuller account, with a coloured plate, was published in the Annual Report of the Commissioner of Agriculture for 1886, pp 120, 121. A disease undoubtedly the same was reported from Australia on orange and lemon leaves by Henry Tyron. (1)

The principal loss from scab occurs in Florida, where it often renders lemon groves so unprofitable that they are cut off and budded to other citrus fruits. In many cases a very large percentage of the fruit is rendered unsaleable, sometimes one-third or even one-half being unfit

(1) Report on Insect and Fungous Pests, No. 1, Queensland, 1889, pp. 144, 145.

for market. It also causes some injury to sour orange trees (before they are budded) when grown for nursery stock.

Scab, or a disease closely allied to it, occurs on very young fruit of the lime (*Citrus limetta*), and in some localities is often so severe as to entirely destroy the crop. For example, a grove in tropical Florida, capable of yielding 500 boxes of fruit annually, when attacked by this disease produced for several years only a few hundred fruits, and the majority of these fell off while still very young. In Louisiana it is said to have attacked Satsuma oranges; in Japan it causes considerable damage to orange groves situated on low, moist land; in Australia it is reported as causing orange and lemon trees to lose their leaves and to yield poor crops, badly affected trees often not setting a single fruit. Probably the annual loss from scab in the United States is not far from $50,000, most of the damage being done to the lemon in Florida.

Symptoms.—The leaves and fruit of trees affected with this disease show small, wart-like excrescences. These excrescences are of various sizes, the diameter ranging from ½ mm. to 1 cm. (one-fiftieth to two-fifths of an inch), but usually being from 1 to 5 mm. They sometimes run together and cover a large portion of the leaf or fruit. In case the fruit is attacked while still very young the tissues below the wart grow more rapidly than normally. This causes tha fruit to become covered with bumps, of irregular pyramidal shape. These grow proportionately with the fruit and on the mature fruit may sometimes be 1 to 2 cm. across and project out nearly the same distance. At first the warts look like small semi-translucent pimples, of a slightly lighter shade of green than the surrounding healthy tissue. In a few days, if the weather be favourable, the warts become prominent, assume a conspicuously light green colour, and look watery. After this they become covered with a delicate fungus, which is at first gray, then dusky, and at last black. Finally the infected tissue covering the tips of the warts is cut off from the healthy tissue below by a formation of cork, and ultimately the cork formation becomes so abundant ss to give a dingy white colour to the old warts. The appearance and development of the warts are much the same on the leaves as on the fruits. There is no formation of a lump below the wart. When the leaves are attacked while still very young much the same effect is produced as in the case of the fruit, the leaf surface bulging abruptly outward and causing the warts to appear seated on hollow, conical protuberances. The leaf is often considerably thickened where the wart is situated, and the persistence of the leaves for at least a year in most cases enables the cork formation to proceed further than is usually the case on the fruit.

Varieties of trees attacked.—Scab attacks only certain species of citrus fruits, the sour orange (*Citrus bigaradia*) being particularly subject to its ravages. It was first noticed in the United States on this host. Both leaves and fruits of affected trees are often severely injured. The greatest loss, however, is caused by its disfiguring the lemon. It attacks the fruits far more frequently than the leaves, and by causing the lemons to become bumpy and warty renders them valueless or nearly so. On the foliage it is never abundant enough to do serious harm. After the sour orange and lemon the Satsuma orange is most

frequently attacked. This variety, probably a form of *Citrus nobilis*, comes from Japan. On this host scab rarely causes serious damage to the crop and is seldom seen on the foliage. In all probability the disease was introduced from Japan into the United States on this orange. In several localities in Florida the first appearance of scab on the sour orange and lemon was shortly after the introduction of Satsuma orange trees. The fact of its being usually inconspicuous on this host explains why it was not noticed first on this species.

Scab, or a disease closely allied to it, occurs on very young fruit of the lime (*Citrus limetta*), causing the fruits to fall while still very small. It has not been found on the older fruits or leaves of this species. It also occurs on the Otaheite orange, a variety of unknown origin, but apparently having some lemon ancestry. All the common sweet oranges (*Citrns Aurantium*), the Kumquat (*C. japonica*), tangerine, mandarin, and king oranges (*C. nobilis*), grape fruit and shaddock (*C. decumana*) seem to be nearly if not quite exempt. Certainly no appreciable damage is ever caused to these sorts by scab. In Florida, however, it is said to occur occasionally on the tangerine and mandarin oranges. In Japan it appears to affect the ordinary cultivated oranges, which are largely varieties of *Citrus nobilis*. In Australia the disease is reported on orange leaves, but no informatiou has been furnished as to whether or not any other sorts are exempt.

Cause.—Scab is caused by a minute parasitic fungus (*Cladispiroum* sp.). So far as known this fungus is found only on the varieties of citrus plants subject to the disease in question. It is a very minute species and usually forms a delicate dusky coating, only a few hundredths of an inch thick, on the surface of the wart. The colourless mycelial threads of the parasite creep about in the superficial layers of the warts and give rise to tufts of erect, brown, branched, and multicellular fruiting branches or hyphæ. On these the dusky, spindle-shaped spores are produced. The spores are borne in abundance near the ends of the hyphæ, which often show numerous scars where spores have been detached. The spores are usually one-celled, but occasionally are two, and very rarely even three-celled. They are very minute, being only about $\frac{1}{3000}$ inch long and $\frac{1}{8000}$ inch wide. The spores germinate by pushing out a slender thread from the side.

Conditions governing infection of the host plant by the parasite.—It has been found that this fungus is remarkably sensitive to weather conditions and can fruit abundantly and spread rapidly only where the air is moist. In Florida the disease often makes no perceptible progress for weeks during the dry spring, but if a few days of damp weather come on, it suddenly spreads and develops very rapidly. Groves in low, moist situations are more subject to scab than those on high and dry lands. The fact that the fungus depends so closely on moist weather for its proper development and spread doubtless explains its almost total absence from California, where the atmosphere is much drier during the growing season than it is in Florida.

Another important condition governing infection is that the tissue must still be growing to be subject to the invasion of the parasite. The period of greatest danger to both leaves and fruits is when they are young and tender and growing rapidly. This explains why old lemon

and sour orange fruits are not badly deformed when attacked by the fungus after the moist weather of summer sets in.

Treatment.—During the spring and summer of 1894 extensive experiments were carried on by one of tne writers to discover, if possible, means of preventing scab on the lemon. Owing to the irregular blooming of the lemon, the prevention of the disease was found to be a difficult undertaking. However, it was demonstrated that Bordeaux mixture and ammoniacal solution of copper carbonate, if properly applied, are efficient. The former is very effective against the fungus, but is more or less injurious to the fruit and foliage of the lemon, while the latter is almost an absolute preventive of the disease and causes very little if any injury to the tree.

It was found highly important that all infected fruits be removed from the tree and from the ground beneath before blooming begins. This measure is absolutely necessary to insure the success of any treatment, and is of itself a great aid in checking the disease. All sour orange trees or sprouts from sour stocks should also be removed from the vicinity of lemon trees, since they are even more subject to scab than the lemon, and because not only the fruit but also the leaves can support a luxuriant growth of the fungus.

The disease can be prevented, to some extent, by planting the trees on dry soil and in localities having little rainfall during and immediately after the blooming season. Directions for treating the disease are briefly as follows:

1. Carefully remove, and burn or bury all diseased lemon fruits, however small, either on the trees or on the ground. Cut down and destroy all sour orange trees or sprouts from sour stock in the vicinity of the lemon trees.

2. Prepare ammonical solution of copper carbonate as follows: Take 5 ounces of copper carbonate and stir up with about a pint of water to a thick paste; then dilute with 1½ gallons of water in a wooden pail. Stir vigorously and at the same time add slowly 2 pints of strong ammonia (1) or 5½ pints weaker ammonia water. (2) Stir until all is dissolved, or at least all but a few granules, and then dilute with water to 50 gallons.

3. Apply the ammoniacal solution with a pump giving a good pressure and furnished with a Vermorel nozzle. The initial spraying should be made when the first young fruits are exposed by the falling of the flowers, the second spraying usually after two are three weeks, a third two or three weeks later on when blooming is nearly or quite over, and a fourth when the fruits are of a size ranging from that of a pea to that of an olive. If necessary a fifth and even a sixth spraying should be made after particularly wet weather. In most cases four and often five sprayings are absolutely necessary. By carefully watching for the appearance of warts on the fruit, particularly during moist weather, the grower can determine when to spray and whether any spraying is necessary after the third application.

---

(1) Aqua ammoniæ fortior (28 per cent.) of druggist.

(2) Aqua ammoniæ (10 per cent.) of druggists.

4. Direct the spray so as to coat all the young fruits evenly, but thinly. It is not necessary to spray the leaves, but it will not be possible to aviod wetting them when spraying the fruit.

5. Watch for scale insects, and if they appear in great numbers use resin wash, kerosene emulsion, or other insecticide. This caution is necessary because in some cases where trees are sprayed with Bordeaux mixture the fungous parasites of the scale are killed, and consequently the scale insects multiply very fast. As yet no such effect has been observed when ammoniacal copper carbonate was used, but the possible danger from this source should be borne in mind

6 If preferred, Bordeaux mixture can be used in place of the ammoniacal solution of copper carbonate. In preparing the Bordeaux mixture, take 6 pounds of copper sulphate and 3 pounds of lime; add 25 gallons of water to each, then mix, and add 6 pounds of dissolved soap to the mixture. This spray must be applied with care, giving the trees only a thin coating, otherwise the youngest foliage may be injured or scale insects induced.

SOOTY MOULD.(1)

Sooty mould of the orange, or smut,(2) as it is sometimes erroneously called, is a malady which frequently causes serious damage. The fungus producing it is of saprophytic habit, deriving its nourishment from the sweet fluids (honeydew) secreted by certain insects, the attacks of which it invariably follows. As the honeydew falls, it strikes principally on the upper surfaces of the leaves and exposed branches and upper portions of the fruit (the stem end, as the fruit are pendulous), and it is on these portions that the sooty mould grows. It develops also to some extent on the lower surfaces of the leaves, but is not so abundant here. In Florida sooty mould follows principally the attacks of the mealy wing or white fly (*Aleyrodes citri* R. & H.), wax scale (*Ceroplastes floridensis*), mealy bug (*Dactylopius citri*), orange plant louse or aphis (*Aphis gossypii* Glover), etc., and spreads, as these insect pests spread. It is only where it follows the mealy wing, however that it becomes serious. In this State it is estimated that the loss it causes is not far short of $50,000 annually.

Besides occurring on all varieties of citrus fruits, sooty mould is frequently found on a number of wild plants in Florida. It is particularly abundant on the gall berry (*Ilex glabra*), red bay, (*Persea carolinensis*), and magnolia. On the gall berry it follows attacks of the wax scale (*Ceroplastes floridensis*), which also infests the orange.

Sooty mould is probably common in all orange countries of the world. In California it causes much damage and is considered a serious malady.

---

(1) Sooty mould of the orange is probably produced by several different species of the genus Meliola. The forms known as *Meliola penzigi* and *Meliola cameliæ* appear to be the most common in Florida. In publications in this country the fungus has usually been referred to *Capnodium citri* and *Fumago salicina*. The disease is known in Italy under the names fumaggine, morfea, nero, etc., and in Germany as Russthan.

(2) Smut is the name very generally applied to diseases produced by the true smut fungi (*Ustilagineæ*).

There it follows chiefly the black scale (*Lecanium oleæ*) and the cottony cushion scale (*Icerya purchasi*). In Louisiana it is very common on the orange, following chiefly, as in Florida, the mealy wing and wax scale. It is also quite common in Spain, Italy, and many other orange growing countries.(1)

Symptoms.—Sooty mould may be readily recognised by the dense sooty-black membrane which it forms over the fruit and upper surfaces of the leaves. This membrane is made up of the densely interwoven, branched mycelial filaments (threads) of the fungus, the individual filaments of which can in some cases be distinguished with a hand lens. When isolated the filaments are seen to vary in colour from olive green to dark brown. They are at first loosely interwoven, but gradually become very numerous and crowded. Finally they become cemented together, forming a dense compact membrane. The fungus as nearly as can be determined, is entirely superficial. Small projections occur on the filaments, but no proof has been found that these penetrate the tissue of the leaf. Apparently they are merely organs of attachment. Large disks (hyphopodia) are also frequently developed, which evidently serve as organs for attaching the mould to the leaf Reproductive bodies of several forms are developed in great abundance, and these are easily carried from tree to tree or from grove to grove through the agency of the wind, insects, birds, or animals.

This disease injures the plant by interrupting the process of assimilation. This is brought about by the cutting off of light and by hindering the passage of necessary gases in and out of the plant. The accompanying insects further injure the plant by sucking the nutritious juices from the cells of the leaves. The growth of the tree is usually greatly retarded, and in serious cases is frequently entirely checked until some relief is found. The blooming and fruiting are commonly light, and in very bad cases are wholly suppressed. In slight droughts the leaves wither quickly and curl up, resembling those on blighted trees. The young fruit becomes covered with the sooty mould and is retarded in its development, frequently never reaching completematurity. It is usually smaller and less juicy than that normally developed, and remains very insipid. It does not change to the normal bright orange colour of mature fruit till very late, and if the membrane of the sooty mould covering it is quite thick the rind remains somewhat green, apparently for an indefinite period, rendering the fruit unsalable. The black coating formed by the sooty mould renders the fruit unsightly and unsalable until it is thoroughly washed, which necessitates a considerable expenditure of time and labour. Even when carefully washed, a process which injures the keeping quality of the fruit, much of it being still small and green is unfit for market.

Treatment.—Where sooty mould followed the attacks of the orange mealy wing, spraying with resin wash or fumigation with hydrocyanic acid gas was found to be very effective. When resin wash(2) is used, the best time for treatment is in winter, between December and the first of March. During this period the mealy wing cannot fly away

(1) In Jamaica, it is common on the Rose Apple, *Eugenia Jambos*, Linn.

(2) The following is the formula for resin wash: Resin, 20 pounds; caustic soda (98 per cent), 4½ pounds; fish oil (crude), 3 pints; water to make 15 gallons;

to escape the spray, being in the mature larval or pupal stage and fixed immovably to the lower surface of the leaf. Furthermore, to be thoroughly effective, the resin wash must remain on the trees at least one or two days, and as this is usually a dry season it is not likely to be washed off soon. If thoroughly done three or four sprayings during the period mentioned, at intervals of one to two weeks, will be found an efficient treatment. It is probably best to delay the sprayings until the fruit has been removed. Should it be found necessary, treatments may also be made during May and the first half of June and again during the latter part of August and first of September.

In spraying it is important to wet thoroughly the under surface of every leaf. In treating this disease it has been found a good practice to trim the trees within, about the trunk and main limbs, thus leaving the greater part of the foliage near the outer parts of the tree. This greatly facilitates spraying, which must be done largely from under the tree, the spray being directly outward in order to wet the lower surfaces of the leaves. Where trees are trimmed out in this way an abundance of water sprouts usually spring up on the main limbs. The mealy wing generally lays its eggs on these in great numbers, and after a brood of mature winged insects have disappeared, it is a good practice to prune off these water sprouts and burn them. In this way great numbers of these insects may be destroyed at slight expense.

Fumigation with hydrocyanic acid gas, in the way it is generally used, is also a very effective remedy. One treatment during the year, if properly made should be sufficient. In the case of fumigation the treatment should be made some time between December and the first of March. During this period the temperature is usually much lower than at any other time, and this is a feature of importance. In treat-

---

Place the resin, caustic soda, and fish oil in a large kettle. Pour over them 13 gallons of water and boil till the resin is thoroughly dissolved, which requires from three to ten minutes after the materials begin to boil. While hot, add enough water to make just 15 gallons. This may be most readily accomplished by taking a tight keg or other tall receptacle and measuring into it 15 gallong of water. Then plainly and permanently mark the height to which the 15 gallons reach. After boiling, the hot solution may be poured directly into this measurins keg and sufficient water added to bring it up to the 15 gallon mark. This serves as a stock preparation.

When this stock preparation cools, a fine yellowish precipitate forms and settles to the bottom of the vessel. The preparation must therefore be thoroughly stired each time before measuring out to dilute, so as to uniformly mix this precipitate with the clear. dark, amber-brown liquid, which forms by far the larger part of the stock preparation. An instrument like a churn dasher, without perferations, greatly facilitlaes rapid and thorough mixing. When desired for use, take one part of the stock preparation to nine parts of water. If the wash be desired for immediate use, the materials after boiling, and while still hot, may be poured directly into the spray tank and diluted with cold water up to 150 gallons. This requires the addition of about 135 gallons of water.

If a fluid stock solution is preferred, the wash may be prepared as follows : Place the same proportions of resin, caustic soda, and fish oil in the kettle and pour over them from 15 to 17 gallons of water. Boil until the resin is thoroughly dissolved and then dilute with cold water, while the solution is still very hot, to exactly 21 gallons. To get this exact amount the barrel may be prepared and marked in the manner already described. This will form a clear, dark, amber-brown solution, which at ordinary Florida temperatures will remain perfectly fluid. For use dilute the whole formula to 150 gallons or use in the proportions of one part of the stock solution to six parts of water.

ing this disease it has been found more effective to allow the gas to act for a slightly longer period than usual, say about forty minutes.

A parasitic fungus, *Aschersonia tahitensis*, has been found which attacks and destroys the larvæ and pupæ of the mealy wing, and bids fair to be of great aid in combating this pest. It forms small, wart-like conical pustules, from 2 to 3 mm. in diameter. At first these are white or orange yellow throughout, but in the mature stage the spore masses become orange red. This fungus is frequently found in groves affected with sooty mould. It dots the under surfaces of the leaves and may occasion alarm if its nature is not understood. Unless examin, ed in an early stage of development, no trace of the mealy-wing scale can be discovered without microscopic study.

When sooty mould follows attacks of the wax scale, mealy bug or orange aphis, thorough spraying with the resin wash or standard kerosene emulsion will be found effective. The time when the treatment should be made is not important in these cases, but if the resin wash is used, a dry season should be selected, when the work will not be rendered uncertain by the liability of rainfall.

FOOT ROT OR MAL-DI-GOMMA.(1)

Foot rot or mal-di-gomma is a disease chiefly of the orange and lemon, and is probably more widespread than any other citrus maladv. It is known to occur in almost all countries where the orange is cultivated, but so far as known appeared first in the Azores Islands, where it was very severe. According to the statement of Fouque(2) it was first noticed in this group in 1834, on the island of San Miguel, where it seems to have originated. From that time until 1840 he estimates that fully one-fourth of the trees were destroyed. It reached its greatest severity on the island in 1840; in 1842 it began to decrease, and in 1873 it had ceased to be very serious. F. Alphonso(3) says that according to general report the malady appeared in Portugal in 1845, in Hyères in 1851,(4) in Lago di Garda in 1855, and in Messina in 1863. According to Briosi(5) the disease first appeared in Sicily in 1862, and afterwards spread to Naples, Liguria, and Lago di Garda, everywhere destroying orange and lemon trees by thousands. Professor Wöhler mentioned in Briosi's monograph referred to in foot-note) found the malady very destructive on the Balearic Islands in 1871. Statements differ in regard to the first appearance of the disease in Florida, but it seems to have been noted here some eighteen or twenty years ago. Dr. A. H. Curtis(6) says: "It appeared about nineteen years ago, though few people remember to have observed it earlier

---

(1) An account of this disease, prepared by B. T. Galloway, was published in Part II of Bulletin No 8 of the Division of Botany, U. S. Department of Agriculture.

(2) Voyages geologiques aux Acores, III, Les Cultures de S. Miguel (Revue des deux Mondes, Paris, Apr. 15, 1873, p. 837).

(3) Alphonso, F., La coltivazione degli aranci nelle Azzorre (Annali di agricoltura Siciliana, Vol. V. 1873, p. 311).

(4) Rendu, M. V., Note sur la maladie des oranges d'Hyères, Extrait (Commissionaires Jussieu, Gaudichaud, Decaisne) Compt. Rend., t. 33, 1851, pp. 681-683).

(5) Briosi, Giovanni, Intorno al mal di gomma degli agrumi (Fusisporium limoni, Briosi) (Atti della R. Acad. dei Lincei, Roma, ser. 3a, Vol. II; Memoria della classe di science fisiche ecc, meeting of May 5, 1878, pp. 485-496).

(6) Curtis, A. H., Sore shin or gum disease (Fla. Expt. Sta. Bull. No. 2, June, 1888, pp. 29-35).

than 1880." The disease is widely distributed in Florida and has by no means run out, but, on the contrary, seems to be gradually spreading. It has also appeared in Louisiana and California, where, in places, it is said to be very destructive.

The damage caused by foot rot is very great, and without question much more than that caused by any other orange disease. The first season after the trees are attacked they may bear an unusually large crop of fruit, but this is generally the last full crop produced. By the next season the tree is either killed or else so reduced that it cannot support much fruit. Sometimes trees are nearly girdled in the space of a few months. Whole groves have been entirely destroyed in the course of a few years. Briosi describes its effect in Italy and Sicily as being most serious; he estimates the damage done in Italy from 1862 to 1878 at more than $2,000,000. In Florida many fine bearing groves have been almost totally destroyed, but the malady does not appear to be so severe here as in some foreign countries. The annual damage it causes in Florida is estimated at about $100,000.

Symptoms.—The first symptom of foot rot is an abundant exudation of drops of gum on the trunk of the tree near the base. This occurs over a limited portion of the bark in the first stages of the disease, and may appear in one or several distinct patches. In this stage the bark will be found to be discoloured, having become brownish, and to contain numerous cavities filled with gum. The inner bark becomes watery and more or less rotten, and has a very disagreeable, fetid odour. As the malady develops, the demarcation between the healthy bark and the diseased patches becomes very apparent The plant endeavours to throw off the disease and a separative layer is formed between the healthy and diseased portions. The patch of diseased bark thus delimited, dries up, the edges break away where the separative layer is formed and gradually curve up in drying. Finally the patches of diseased bark are thrown off. The death and decay of the tissues caused by the disease extend through the bark and apparently for some distance into the wood. The cambium layer, the most vital part of the tree, situated between the bark and the wood, is destroyed, and when the bark is thrown off there is no possibility of new bark growing over that portion The patches of bark which first become diseased, are irregular in shape and vary greatly in size, but are usually from 1 to 4 inches in diameter. The exudation of gum occurs principally in the spring or in early autumn, after the rainy season, while delimitation and detachment of the bark usually take place during the summer or winter.

As the disease progresses, gum exudes on other portions of the bark which are in turn thrown off. It is quite common for a circle of bark surrounding an old diseased spot to become affected and be thrown off, thus enlarging the spot. The malady gradually spreads in all directions, but principally down on the main crown roots and around the trunk in a lateral direction. Year after year other portions of bark become affected, until the tree is entirely girdled and thereby killed. In malignant cases the disease runs its course and kills the tree in two years or less, while in mild cases the growth of the tree is scarcely affected, and in a few years the wounds are often completely covered with the new growth from the sides. The destruction of the bark on

the trunk does not usually extend over 1 or 1½ feet above the ground, but occurs on the roots for some distance below the surface.

Trees affected with foot rot appear at first as if they were suffering from lack of nourishment. The foliage becomes light yellow and scanty the leaves developed being smaller than usual; the tree bears considerable fruit, apparently of normal size and good quality. This abundant fruiting is in marked contrast with blight, where a profuse bloom is formed, but very little fruit set. In trees suffering from this disease the small limbs die first, but as the malady progresses large limbs succumb, thus giving the tree a ragged appearance. Again, in marked contrast with blight and with severe cases of die back, no water sprouts develop from the interior of the tree top or from the trunk. In Florida trees are not usually attacked until they are quite old and have been bearing fruit for a number of years. In other regions, however, young trees are said to contract the disease.

Psorosis a disease (1) known in Florida as "tears" or "gum disease" is often confounded with foot rot, but is unquestionably quite distinct. In appearance it is similar to foot rot, but with it the diseased spots occur on the limbs and occasionally on the trunk, but never on the roots so far as known. Psorosis does not kill the bark entirely, but extends only to the middle layer, the inner bark and cambium layer remaining healthy.

Varieties of trees attacked.—Probably all species of citrus trees may contract mal-di-gomma, but some are very much more subject to it than others. Sweet seedling orange trees (*Citrus Aurantium*) are particularly susceptible, and it is in old groves of these that the most damage is done. Sweet orange used as stock ror budding is also liable to the disease. This malady is very destructive to the lemon (*C. limonum*), occuring quite commonly on all varieties. Grape fruit (*C. decumana*) is frequently affected, but is much more resistant to attacks than the sweet orange or lemon. Indeed, it is seldom that this fruit is seriously damaged. Tangerine and mandarin oranges (*C. nobilis*) are occasionally affected, but the damage is not usually very great. The sour orange (*C. bigaradia*) is apparently almost wholly free from mal-di-gomma. The writers carried on a careful search for the disease on this species, but succeded in finding only two uuquestionable cases. The sour orange used as a stock for budding, remains free from attacks, and in Florida its use for this purpose is almost a sure preventive of the disease. It is probable that the disease occurs on the lime (*C. limetta*) and citron (*C. medica*) also, but no cases have as yet been observed in Florida.

Cause.—Mal-di-gomma has been studied extensively by many investigators, but as yet the cause of the disease is not surely known. It is thought by many to result from the attacks of some parasitic organism, and Professor Briosi(2) describes and names a fungus (*Fusisporium limoni*) which he finds always accompanying the disease. He is inclined to consider the fungus the cause of the trouble, but is in doubt as to whether it is the primary cause. He says, however: "I do not believe there can be any doubt that its presence accelerates the disorganization of the tissues and aids in extending the disease."

---

(1) From the Greek, meaning an ulcer.
(2) Briosi, loc. cit., 495.

The manner in which the disease spreads, appearing at different dates first in one country and then in another, and extending gradually from grove to grove, strongly indicates that it is contagious, being caused or at least greatly aggravated by some parasitic organism. Some investigators also think that the disease is due to physiological derangements, for instance, imperfect aeration of the roots. The most effective treatment known is based largely on this supposition.

Observation has shown that the disease is most common where any of the following conditions exist: Improper drainage; planting the trees so close together that the ground is continually shaded and kept moist; continuous use of organic fertilisers; excessive cultivation; continuous excessive irrigation, which keeps the soil water-soaked; and deep planting.

Trees badly affected with the disease frequently recover if transplanted to some other location, on apparently similar soil, and given plenty of room. A remarkable instance of this was seen by the writers in a case where 40 acres were planted out some five years ago with large trees affected with foot rot. After three years every tree of the several thousand transplanted to this grove seemed to have fully recovered.

Treatment.—Very many attempts have been made, both in Europe and in the United States, to find remedies for this malady. One of the most important discoveries is that it can be prevented by using immune or resistant stocks. It was early noticed that the sour orange and trees of sour orange stocks were almost absolutely exempt from the malady. By using this stock in setting out young grove the disease can be effectually prevented. On high, dry soils, not suited to the sour orange, grape-fruit stock can be used, as it also is quite resistant.

Many curative treatments prove more or less beneficial, and this has led to conflicting claims as to which is the best. In many cases it has been found sufficient to simply dig away the earth and expose the roots. This probably explains why so many different applications made to the roots seem to benefit the tree. The very act of opening the soil and exposing the roots to the air of itself tends to effect a cure. As the disease is probably caused by a parasite, it is important that no wounds be made on healthy roots in removing the soil. It is desirable to cut away all infected bark and wash the scars with some antiseptic solution, such as sulphurous acid, carbolic acid, or sulphur wash. Where trees are closely planted, it is usually necessary to remove and transplant a part of them to give light and air free access to the roots and trunk. The use of highly organic nitrogenous fertilizers should be avoided, and also excessive or deep cultivation.

The following is a summary of the treatment recommended for foot rot:

1. Remove the earth from about the roots for 2 to 3 feet from the trunk, being careful not to wound the healthy roots. When the groves are furnished with irrigation plants of the kind commonly used in Florida, which are capable of delivering a stream of water under considerable pressure, the earth should be washed away rather than dug away from the roots. A good way to do this is to first dig a hole some 3 feet in diameter and 2 to 3 feet deep about 6 feet from the tree; then stand on the opposite side of the tree and wash the soil from under the

tree, driving it into the hole previously dug. If no hole is dug before washing out is attempted, the soil is likely to bank up around the tree and make it difficult to expose the roots sufficiently. In all cases the roots should be left exposed till recovery takes place, except possibly during a portion of the winter when severe freezes are likely to occur.

2. Cut away all diseased spots in the bark or the roots or trunk and cover the wounds with one of the following antiseptic solutions: (1) Sulphurous (not sulphuric) acid, 15 parts to 85 parts of water. This may be sprayed on the roots. (2) Carbonic acid, 1 part of crude acid to 1 part of water. When diluted 1 to 5 this may be sprayed over the roots. (3) Sulphur wash made by putting 30 pounds of flowers of sulphur in an iron or wooden vessel and mixing enough water (about 12 quarts) with it to make a stiff paste. To this add 20 pounds of finely pulverized 98 per cent caustic soda and stir vigorously. In a few moments the mass becomes hot, turns brown, and then boils up and becomes liquid. As soon as the violent boiling has ceased, add enough water to bring up to 20 gallons and strain into a barrel that can be kept tightly corked. For covering cut places use 1 part of this stock preparation to 1 part of water. The roots may be sprayed with one part of stock solution to 10 of water.(1) All these solutions should be kept in wooden or glass vessels and should not be allowed to come in contact with metals. It is possible that any of these applications will prove of benefit even if the diseased spots are not cut out. In this latter case however, care should be taken to saturate the bark of all diseased spots with the solution.

3. When the diseased trees are old and closely set, so that the ground is much shaded, every other tree should be removed and replanted in a new grove.

4. Avoid highly nitrogenous organic fertilisers in diseased groves, using preferably nitrate of soda or sulphate of ammonia as a source of nitrogen.

5. All tools used in infected groves should be cleaned and washed with crude carbolic acid before they are used in healthy groves.

6. In setting new groves dead trees should be replaced with trees budded on sour orange stock.(2)

7. Avoid excessive and deep cultivation in diseased groves. Injuries to the roots, such as are often caused by deep ploughing, seem to greatly favour the spread of the disease.

MELANOSE.(3)

Melanose which in some groves is causing considerable damage, was first brought to the attention of the writers in November, 1892, by Mr. J. A. Barnes, who sent specimens to us from Citra. It apparently attacks all citrus fruits, but develops somewhat more freely on the grape

---

(1) Two quarts of the stock solution to 50 gallons of water makes a very effective remedy for rust mite, and 1 gallon to 50 gallons of water for the six-spotted mite.

(2.) Sour stock does better than sweet on low, wet hammock lands, and as well on flatwood land. For high, dry lands grape-fruit stock may be used, since sour stock does not do well and grape fruit is almost exempt from foot rot.

(3) From the Greek, black and disease.

fruit than on the other varieties. It is known to affect the grape fruit, common sweet orange, sour orange, lemon, mandarin, and Satsuma. The disease develops most freely on young, rapidly growing, vigorous shoots. It resembles to some extent the injury produced by the rust mite, and was for a time confounded with this disease. Its refusal to yield to the treatment for rust mite, however, led to the discovery that it is distinct from rust. (1)

The disease is undoubtedly of very recent origin or introduction. It has spread rapidly in the region about Citra, and many of the groves there are badly affected. The malady has also been found to occur to some extent at Ocala, Stanton, and Sandford, and is apparently spreading rapidly.

The foliage of trees attacked by this disease is greatly injured, and consequently the general vigour and productiveness of the tree much reduced. The growth of young trees is retarded, and they are apparently permanently stunted if the disease is allowed to continue. The fruit produced is mostly disfigured, some of it so badly as to be unsalable. This is particularly the case with lemons, they, unlike russet oranges being almost wholly unsalable. At Stanton where the malady occurs in lemon groves to some extent, from 3 to 4 per cent of the fruit was affected in 1894, and about 2 per cent rendered unsalable. On badly affected grape fruit and orange trees fully 90 per cent of the fruit may be more or less disfigured by melanose. Probably 1 per cent of these are rendered unsalable, The total damage produced by this malady is as yet slight, being about $5,000 annually. It appears to be spreading rapidly, however, and may ere long become one of the most common and most injurious diseases. Great care should be taken to prevent the introduction of this malady into California and other orange-growing countries where it is not yet known to occur.

Symptoms—The most conspicuous symptom of melanose is the occurrence of small, dark brown spots on the leaves, young stems, and fruits. On the leaves and fruits the individual spots, when distinct, are nearly round and are slightly elevated above the surrounding surface. On the stems the spots are usually roundish, but are frequently somewhat elliptical or oblong and elevated, as on the leaves. Only the elevated spot is discoloured, the surrounding tissue being of normal colour. The spots are at first very minute and yellowish. They gradually increase, however, and swell up, changing to dark brown or nearly black. Many of the spots finally burst near the centre and show a small irregular fissure. Very commonly the under side of the leaves show minute depressions, corresponding to the spots located on the upper surface. On young partially grown leaves this latter character is usually very evident, each brown spot occurring on a slight elevation of the leaf. The spots vary considerably in size, ranging usually from $\frac{1}{4}$ to 1 mm. ($\frac{1}{100}$ to $\frac{1}{25}$ inch) in diameter. On the common sweet orange and sour orange they range in size from $\frac{1}{4}$ to $\frac{1}{2}$ mm. ($\frac{1}{100}$ to $\frac{1}{50}$ inch). On the grape fruit they are from $\frac{1}{2}$ to 1 mm. ($\frac{1}{50}$ to $\frac{1}{25}$ inch) in diameter, the individual spots being usually much larger and more conspicuous than on common orange or sour orange. On the common orange 388

(1) A brown discolouration of the fruit, caused by the attacks of a surface-feeding mite, *Phytoptus*.

spots were counted on a square centimetre of a badly infected leaf and 44 spots on a square centimetre of one slightly infected. In the grape fruit only 130 spots to the square centimetre were found on a badly infected leaf; these were partly confluent, forming an almost continuous blotch. Where the spots are very abundant, they frequently run together, forming large, irregular, dark brown blotches. This frequently occurs on all species of citrus trees affected with the disease, and is found on stems, leaves, and fruits. On the fruits in particular this is of frequent occurrence. As the fruit ripens, the blotches, which are hard and brittle, sometimes become considerably checkered and fissured, similar to the cracking of mud in drying.

The spots are to some extent formed on both surfaces of the leaf, but are much more abundant on the upper surface. This character is more particularly noticeable in the grape fruit than in other species of citrus. On grape fruit the spots are almost wholly limited to the upper surface. In the common sweet orange and sour orange they occur abundantly on the lower surface, but are still more numerous on the upper surface. On the different portions of the fruit and young stems the spots are apparently uniformly abundant. This malady is most severe on the lower portions of the tree, but the characteristic spots are also found on the leaves and twigs in the tops of large trees, nearly 30 feet from the ground.

The infection, it appears, usually takes place at an early stage in the development of the leaves and stems, and if the disease becomes severe the affected organs are considerably modified in appearance. The leaves become greatly distorted and wrinkled and remain much smaller and more pointed than normally. Many of the leaves fall before reaching maturity, only a scanty foliage remaining on badly affected branches. The branches are also considerably contorted and stunted in severe attacks.

Cause.—From studies that have been made of this disease it seems very probable that it is caused by some vegetable parasite, although the microscopic studies which have thus far been carried on have failed to reveal the presence of any such organism. The disease is apparently contagious, spreading from definite centres. In some groves infected areas are plainly seen. In the centres of these areas, where the disease first started, the trees will be found to be very badly affected, but toward the margins the malady gradually becomes less apparent.

Melanose appears to be of an entirely local nature. In its growth and development each spot is entirely independent of any other spot, probably being caused by a separate infection. The tissue between the diseased spots is evidently perfectly healthy outside of the general debility which results from the infection of such a large portion of the leaf. The strict localization of the disease, so similar to what occurs in scab, again strongly suggests that the disease is caused by some vegetable parasite. Infection can take place apparently only when the tissues are quite young. If the leaves and stems escape the disease until they are nearly full grown the danger of infection is past. This is the case also with fruits, and therefore spraying to prevent the disease must be done early, while the fruits are small. After they reach an inch in diameter they appear to be safe from infection and spraying may then be discontinued.

Preventive measures.–In the summer of 1894 experiments with various fungicides were carried on at Stanton and Citra, with a view to find a preventive of the disease. The copper fungicides, i. e., Bordeaux mixture and ammonical solution of copper carbonate, were found to almost wholly prevent the disease if properly applied. In two plats of lemon trees at Stanton, sprayed with Bordeaux mixtures (6 pounds of copper sulphate and 3½ pounds of lime to 50 gallons of water), melanose was absolutely prevented, the most careful search failing to disclose a single fruit showing the characteristic spots. The sprayings were made once a week and twice a week, respectively, for a term of ten weeks, beginning February 3. On an orange tree sprayed at the same time with the lemons the treatment was equally effective. However, both the lemon trees and orange trees were somewhat injured by the Bordeaux mixture, probably largely because of the numerous sprayings given. On adjoining unsprayed lemon trees from 2 to 4 per cent of the fruits and a larger per cent of the foliage were considerably spotted with the disease. Perhaps half the spoted fruits were so badly disfigured as to be unsalable. In a plat of lemon trees sprayed weekly with ammoniacal solution of copper carbonate (5 ounces to 50 gallons), beginning February 24 and continuing eight consecutive weeks, no melanose could be found on any of the sprayed trees. However, very little developed on the unsprayed trees adjoining this plat.

In another series of experiments at Citra, several plants of very badly infected orange trees were sprayed with Bordeaux mixture (6 pounds of copper sulphate and 3½ pounds of lime to 80 gallons of water). In one of these plats sprayed twice, April 19 (shortly after flowering) and May 16, melanose was almost wholly prevented. Only two slightly spotted fruits were found on the entire plats of twenty-five large trees. Certainly not one-tenth of 1 per cent of the fruit showed even a trace of the disease. On the adjoining unsprayed trees fully 90 per cent of the fruit was diseased, some 50 per cent of it being very badly disfigured. In these experiments the trees also were injured to some extent, probably largely because of the abundance of scale insects on sprayed trees. As melanose was absolutely prevented by Bordeaux mixture of the strength above, it is highly probable that weaker sprays would be equally effective. It is likely that more sprayings will be necessary in treating melanose on the lemon than on the orange because of the more extended flowering period of the former. Although the experiments were mostly with Bordeaux mixture, which has proved fully effective in preventing the malady,it is very likely that ammoniacal solution of copper carbonate will be the most practical remedy, because it is not so apt to injure the trees and will probably prove as effective as Bordeaux mixture.

The following is a summary of practical directions for keeping melanose in check: In treating the lemon for melanose, spray with Bordeaux mixture(1) or ammoniacal solution of coppor carbonate.(2) Spray first about a month after the beginning of the spring blooming, or

---

(1) Take 6 pounds of copper sulphate and 3 pounds of good lime to 80 gallons of water. Slack the lime carefully and dissolve the copper sulphate; then dilute each constituent with water to 25 gallons and mix. Add 6 pounds of soap, dissolved in as many gallons of hot water, and finally add enough water to bring the mixture up to 80 gallons. A resin soap suitable for adding to fungicides can be prepared

when the oldest of the young fruits are about the size of an olive. Spray again about a month after the first application, after flowering has ceased and the youngest fruits are the size of a pea. A third spraying may be made a month later if it is found necessary, but two sprayings will probably be sufficient.

In treating the orange and grape fruit for this disease, use Bordeaux mixture or ammoniacal solution of copper carbonate, prepared as indicated above. Two sprayings should be made, the first about two weeks after the flowers have fallen and the second about a month later. A Vermorel nozzle and a pump giving a good spray should be used. The spray must be applied to the fruits in the form of a fine mist, covering them thinly and evenly. In this way the leaves will be sufficiently coated without any special effort being made to wet them.

SUMMARY.

1. *Blight* attacks trees only when over 5 years old and which are in bearing. It is first manifested by a sudden wilting of the leaves, which soon becomes so bad as to continue even in wet weather. At the beginning of the rainy season following the wilting, vigorously growing sprouts start from the trunk and larger branches. These often continue growing several years, but finally sicken and gradually decline. The spring following the wilting of the top, the branches, which have now become nearly leafless, bloom profusely. These flowers continue to appear for two or three weeks after normal blooming is over. They are small, however, and almost never set fruit. Very little fruit is produced by blighted trees After flowering the branches usually die, often leaving only the sprouts from the trunk alive and growing. The whole top may be attacked at once or only a single branch, but in any case the entire top ultimately becomes blighted. The affected trees usually linger for many years and rarely die outright, though they may be finally reduced to mere stumps. The roots for the first year at least, seem perfectly normal. The annual loss from this disease in Florida is about $150,000. The cause is unknown but it is probably a contagious malady, and, so far as known is incurable. Affected trees should be dug up and burned as soon as they show the disease and healthy ones set out in their places.

2. *Die-back* or *exanthema* is apparently caused by mal-nutrition, accompanied by improper drainage, improper cultivation, etc. The disease

---

very easily as follows: Take 40 pounds resin, 20 pounds sal soda (crystaline), and water to make 25 gallons. Place the resin and sal soda in a comparatively large kettle with 5 quarts of water. Boil, meanwhile stirring briskly, until the resin and sal soda are thoroughly melted together and form a frothy mixture without lumps. Now add 20 gallons of cold water, pouring it in rather slowly and with short intervals between, and avoid chilling the mixture too suddenly. When all of the water is added, bring to a boil; then pour out the hot solution, straining through a coarse cloth, and add sufficient water to make 25 gallons of the solution. This, if correctly made, forms a thick, dark-brown, translucent, syrupy solution, which may be preserved as a stock preparation- About 2 pounds of soap are contained to the gallon and the cost is only about 1½ to 2½ cents per gallon, while ordinary good hard soap costs five to twelve times as much.

(2) See directions for making on p. 92.

may be recognised by the very large, dark, pointed leaves, and the reddish brown stains on certain of the new growth twigs, which latter die back for a considerable distance. Brown eruptions occur very abundantly on young and old twigs, all of which finally dieback. Swellings produced by gum pockets in the wood occur very abundantly on the young twigs. Multiple buds form in the axils of the leaves. Diseased trees bear little fruit, and that formed soon assumes a pale green colour, then a light lemon yellow, becoming coloured prematurely. The fruits are very commonly more or less disfigured by the characteristic reddish-brown stain. A very large percentage split open and drop before ripening. The loss from this malady is about $100,000 annually in Florida. Withholding all organic nitrogenous manures, ceasing to cultivate, and mulching the soil have been found beneficial treatments. In cases where the disease has been produced by wet soils good drainage will frequently be found an effective remedy.

3. *Scab or verrucosis* attacks principally sour oranges and lemons, the common sweet orange being exempt. It occurs in the United States, Australia, and Japan, from which latter country it was probably introduced into America. It causes small excrescences to appear on the young leaves and fruits. These excrescences are at first of a pale, watery green colour, but soon become coated with a dusky fungous growth composed of a species of *Cladosporium* (the parasite which causes the disease). The tissues of the warts infested by the fungus are cut off from those below by a formation of cork, which ultimately becomes so abundant as to give the excrescence a gray color. The full-grown warts are $\frac{1}{25}$ to $\frac{1}{4}$ of an inch in diameter and are often confluent. When attacked while still very young, the leaves and fruits are greatly distorted by the disease. In the fruit, especially, the warts cause the tissues below to grow too fast and to form large bumps. These, with the gray excresences, so disfigure the fruit as to render it nearly valueless. The fungous parasite causing scab is able to spread and infect new spots only during moist weather. For this reason very dry regions are nearly exempt from the malady. The loss from this disease results principally from its action in disfiguring lemons. It does most harm in Florida, where it causes an annual loss of not far from $50,000. The disease can be prevented on lemons by spraying the young fruits from three to five times with ammoniacal solution of copper carbonate.

4. *Sooty mould* is a black fungus, which follows the attacks of certain honeydew-secreting insects. It may be recognized by the sooty black membrane which it forms principally over the upper surfaces of the leaves, fruits, and stems. The disease greatly reduces the productivity of the trees, and the oranges formed are so badly disfigured by the covering of sooty mould as to be rendered unsalable. The annual loss in Florida is not far from $50,000. Thorough spraying with resin wash has been found very effective. Between December and March of each year three sprayings should be made. Fumigation with hydrocyanic acid gas has also been found an effective remedy. The applications should be made during the winter. A parasitic fungus has been found which promises to be a very great aid in combating this malady.

5. *Foot rot* or *mal-di-gomma* is the most widespread of all orange disease. The total damage which it causes is greater than that resulting from any other one malady, in Florida alone, amounting to nearly $100,000 annually. It may be recognised by the exudation of gum from definite patches of the tree near the base: A separative layer is formed by the tree delimiting the diseased bark; the edges of the bark, thus freed, curve up away from the tree, dry out and finally fall off. These patches are enlarged by the disease spreading to the adjoining bark. Other patches also form on fresh bark. The malady spreads down the roots and latterly around the trunk, It extends through the bark and cambium layer into the wood, killing all the tissues as far as it extends. In many cases the tree is finally girdled, which of course results in its death. The accompanying or premonitory symptoms are sparse foliage small yellow leaves, and the dying of small limbs over the tree. The disease is apparently contagious probably being caused by some minute parasitic organism. It is also thought that improper aeration of the roots induces the disease. Sweet seedling orange trees and lemons are particularly subject to the malady, while grape fruit is but slightly subject to it, and sour orange is almost wholly exempt. The malady may be prevented by using sour orange stocks on lowland, and flat woods, and grape fruit stocks on high and dry pine lands. Removing the soil from around the crown roots is the most effective treatment. This can be best done by using a stream of water under considerable pressure. This washes the soil away without injuring the roots, cutting away the diseased portions of bark and wood and washing or painting the wounds with a solution of sulphurous acid, carbolic acid, or sulphur wash is recommended as beneficial. Avoid the excessive use of nitrogenous organic manures, excessive cultivation, and immoderate irrigation. Give good drainage in all cases and if the trees are planted too thick, so that the ground is shaded, thin them out.

6. *Melanose*, which attacks all citrus fruits is a new disease. It is as yet known only from a few points in Florida and does not cause much damage, probably only about $5,000 in 1894. However, it seems to be spreading, and is capable of causing great losses should it become widely distributed. It forms minute brown spots on the leaves, twigs, and fruits. These brown spots appear when the fruit and leaves are still young, and do not form on old tissue. They reach a size of from $\frac{1}{100}$ to $\frac{1}{25}$ of an inch in diameter and are often very numerous sometimes running together over large areas, greatly staining and disfiguring the fruit. In bad cases the trees are much injured by the malady, but ordinarily most of the damage results from the discolouring of the fruit. Lemons particularly are unsaleable if attacked by melanose to any considerable extent. The cause of this disease is not certainly known but it is very probable some minute vegetable parasite. Bordeaux mixture or ammoniacal solution of copper carbonate are very effective remedies if applied two or three times to the young fruits.

FERNS: SYNOPTICAL LIST—LII.

Synoptical List, with descriptions, of the Ferns and Fern-Allies of Jamaica. By G. S. JENMAN, *Superintendent Botanical Garden Demerara.*

29. *Acrostichum cervinum,* Swartz.—Rootstock ligneous, short repent, densely clothed with brown or ferruginous long filamentose silky scales; stipites contiguous or apart, erect, light brown, $\frac{3}{4}$-$1\frac{3}{4}$ ft. l., clothed at the base like the rootstock; fronds pinnate, erecto-spreading or pendant, $1\frac{1}{4}$-$2\frac{1}{2}$ ft. l. $\frac{3}{4}$-$1\frac{1}{2}$ ft. w., composed of a terminal pinna and few or several inequilateral oblong-lanceolate lateral ones, which are 6-9 in. l. $1\frac{1}{4}$-$2\frac{3}{4}$ in. w. the upper base deeply rounded, the inferior gradually cut away to nothing, the apex tapering and acuminate, subcoriaceous. light green, glabrous; veins patent, simple and forked, close connected in the thickened margin; fertile fronds regularly bipinnate, the pinnae linear acuminate; segments very numerous, 3-6 li. l. about 1 li. w. soriferous on both sides. Pl. Fil. t 154 Sl. Hist. t. 37. 41. f. 2. Herb. pp. 79-87. Fil. Exot t. 43. *Osmunda,* L. *Polybotrya,* Kaulf. *Olfersia,* Kze.

Common in moist forests up to 3,000 or 4,000 ft. altitude. Fronds are occasionally found intermediate in character between the normal barren and fertile, with the pinnae pinnatifid, the veins curiously pinnate and areolated in the narrow pectinate segments, barren throughout, or partly, or completely fertile.

30, *A. nicotianæfolium,* Swartz.—Rootstock ligneous, free-creeping, paleaceous; stipites apart, erect, 1 - 2 ft. l. dark scaly at the base, light brown, fronds erect, 1 - $1\frac{3}{4}$ ft. l. $\frac{3}{4}$ - 1 ft. w., composed of a large terminal pinna and 2 - 4 pairs of smaller erecto-spreading lateral ones, which are oblong or orate-lanceolate, acuminate, rather rounded or subcuneate at the base and stipitate 6 - 10 in. l. $1\frac{1}{2}$ - 3 in w., even or somewhat repand or sinuate, light or dark green, chartaceous, naked; veins copiously areolated, areolæ very fine, with stronger transverse arched veins connecting the primary costate series; fertile fronds on long stipites, the pinnæ greatly reduced.—Pl. Fil. t. 115. Sl. His. t. 39. Herb. p. 84.Hook. garden Ferns, t. 26. *Gymnopteris,* Bernh. *G. acuminatum,* Willd.

a. var. saxicolum, Jenm—Rootstock ascending, stipites and rachises fibrillose, texture thinner, fertile pinnæ larger and usually rather more in number.

Common in woods and forests among the lower hills; variable in the number of pinnæ and size of the fronds. The type creeps horizontally under ground, while *a,* which has a darker colour, is more generally scaly, with more decidedly oblong, rather than ovate formed barren lateral pinnæ and somewhat larger fertile ones, grows above ground ascending the sides of rocks or stumps. Both are equally common on the mainland.

31. *A. alienum,* Swartz,—Rootstock free-creeping, scaly, stipites erect, scattered, 1 - $1\frac{1}{2}$ ft. l., deciduously fibrillose below, light brown; fronds 1 - $1\frac{1}{2}$ ft. l. $\frac{1}{2}$ - 1 ft. w., pinnate, with a pinatifid and lobed acuminate upper part; pinnæ several erecto-spreading, oblong-lanceolate, acuminate, the lower ones stipitate, the upper adnate and decurrent on the rachis, 6 - 8 in. l. 1 - 2 in. w. roundly lobed on each side, the lowest

pair often pinnatifid and enlarged on the inferior side membrano-chartaceous, naked, dark green, costæ and ribs prominent beneath; areolæ copious, angular, a line of narrow arches along the costæ on each side devoid of included smaller meshes, no stronger transverse veins; fertile fronds on longer stipes, similar in form, but the pinnæ much reduced and less lobed, or occasionally entire. Pl. Fil. t 9 - 10 Hook. Gen. t. 85. *Gymnopteris*, Bernh.

a. var. *fl agellum*, Jenm.—Fronds large, upper part much prolonged into a distantly pinnatifid or lobed and winged tail, which is viviparous at intervals; pinnæ more numerous and deeply cut.

b. var. *G. semipinnatifida*, Fée. Pinnæ 2-4 to a side, 2-4 in. w. entire crenate-sinuate or the lowest pair lobed on the under side and forked, with a large, depending, inferior segment; terminal pinna usually trilobed, texture thicker; fertile fronds reduced, but confirm in shape of the pinnæ.

Frequent in the eastern parishes, on rocks by streams or in very moist forests among the lower hills up to 1,000 or 1,500 ft. alt. A highly variable species, of usually membranous texture, dark cloudy green colour but unmistakable in all its forms.

32 *A. aureum*, Linn.—Rootstocks stout, erect, solitary or in masses forming large elevated clumps, paleaceous on the crowns; stipites caespitose, erect ligneous, naked above the paleaceous base, 1½-2½ ft. l. straight or somewhat flexuose, flattish channelled, impressed laterally with pale green vertical streaks and having two or three alternate pairs of black indurated spinescent spurs; fronds erect stiff very coriaceous, glossy, light green, simply pinnate, oblong-lanceolate, 3-4 ft. l. 1-1½ ft. w.; pinnæ more or less distant, erecto-spreading, converging forward, a dozen less or more to a side and a similar free terminal one 6-10 in. l. 1¼-1½ in. w. obtuse or emarginate-apiculate, cuneate at the base and petiolate, black and indurated in the acute axils, pellucid, cartilagenous-edged, the superior fertile throughout, the lower half or two thirds as uniformly barren; venation translucent areolæ fine, directed at an oblique angle to the margins; sori covered by amorphous corpuscles which are pelate and obtusely angular or radiate, coffee-coloured and finally displaced by the bursting of the sporangia, which then alone appear.—Pl. Fil. t. 104. Sl. Herb. p. 50. *Chrysodium vulgare*, Fée.

Abundant in lagoons and other wet places, preferring alluvial littoral situations and brackish water. This is the true typical species, in which the fructification is uniformly confined to the upper pinnæ only of the fronds and the corpuscular covering of the sporangia is coffee-coloured, the individual corpuscles being, variably, distortedly club shaped; a stiff, ligneous, coriaceous species, once much regarded by herbalists, according to Sloane.

33. *A. lomarioides*, Jenm.—Rootstock, erect, massive, paleaceous stipites caepitose, erect, stout, subfleshy, 1½ - 2½ ft.. l. ½ in., or more thick, prominently ribbed longitudinally, subangular, naked, except a few basal scales arising from the caudex; fronds erecto-spreading, pinnate, 3 - 4 ft. l., 1 - 2 ft. w.. a little reduced at the base, suddenly so at the apex coriaceous, light or dark green, naked, pinnæ patent, 2 - 2½ doz. to a side, close or crowded, the face turned up and transverse with the rachis, slightly petiolate or quite sessile, ¾ - 1¼ ft. l., 1½ - 2 in. w., the base cuneate, the apex acute, margins even, undulately repand, car-

tilaginous-edged; venation translucent, areolae very fine, oblong, directed to the margin; fertile fronds, quite erect, much taller, on stouter more fleshy and longer stipites; corpuscles pruinose, darker with age, sausage-shaped, pale and translucent. *Chrysodium* Jenm, in Timehri, vol. IV, part 2, *A. aureum*, Linn. Eat. Fer. N. Am. p. 58., Bermudas.

A much larger species than the last, of shuttlecock habit the sterile fronds shorter, spreading on the exterior, the fertile taller, and erect in the centre. It is marked by numerous distinguishing characters from the last with which it has been long confounded, the more obtrusively obvious of which are—its much larger size, numerous crowded fronds, the barren and fertile being uniformly separate—all the pinnae of the one being barren and all of the other fertile,—much more numerous sessile leaflets (turned transversely with the rachis, the plane to the sky like the blades of a step-ladder) intestiniform translucent pale--coloured corpuscles covering the sporangia, which give a pale pruinose colour to the soriferous under surfaces. As indicated above, this is the plant figured in Eat. Fern. N. Am. for *A. aureum*, though true *aureum* is also found in Florida. It ranges from Florida and the Bahamas down through the West Indies and Guianas to the Brasils.

Tribe XV. Ceratopterideæ.

Sori linear or interrupted, on the longitudinal veins, diffuse; sporangia sessile, rather large globose, very fragile, having broad rudimentary or more or less extended or complete striated vertical ring, splitting at length crosswise; spores rather large granular.

This is a singular division, of very doubtful affinity, represented by a single anomalous species. I follow Eaton in placing it after *Gleicheniaceæ*. It is marked from any other by the globose sessile capsules having to some, much varying, extent a broad vertical band.

Genus XXXVII. Ceratopteris, Brong.

Sori linear, in one to two rather irregular rows; receptacles formed of the longitudinal distantly connected veins, upon which the sporangia are laxly arranged or scattered, and covered by the membranous reflexed conniving indusæform margins; fronds herbaceous, barren and fertile difform.

The linear sori covered by the membranous margin which forms an adventitious involucre, might seem to suggest to ally this genus with *Pterideæ*, from which however the character of the sporangia distinctly and widely removes it. The only representative is a widely spread and variable acaulescent aquatic plant.

1. *C. thalictroides*, Brong.—Stipites several, springing from central scaly buds, which by adhesion form the short herbaceous rootstock, ribbed, with rather large longitudinal air vessels; fronds herbaceous, light grass green, of two kinds; the barren 3-6 in. each way, roundly lobed or pinnatifid, viviparous in the axils, the veins freely reticulated, the stipites short; fertile 6-18 in. each way, on stipites 6-10 in. l. decompound, tri-quadri-pinnatifid; ultimate segments linear, convolute but flattened, divaricating, a line or less wide, and 1-2 or 3 in. l. the margins conniving beneath over the sori; veins in narrow longitudinal areolæ.— Eat. Fer. N. Am. pl. 80. *Parkeria pteroides*, Hk., Hk. & Gr Fil. t. 97.

Frequent in still shallow waters of the central and western parishes. The sterile fronds are prostrate and rest upon the surface of the water or mud, the fertile are erect or erecto-spreading held up clear of the water, and while the former are leafy and more or less subentire, the latter are much divided, all the parts being narrow and linear or acicular. A transverse section of the stem shows numerous vascular bundles mainly arranged at intervals on the outside, with abundant intervening air channels. It possesses great fecundity, and multitudes of spores germinate on moist surfaces, where the great majority eventually perish from lack of water. It also grows from the axillary buds which are produced by both kinds of fronds, though chiefly by the barren, those of which, too, develop more constantly into leafage. Young barren plants are often nearly covered by the pale developing plantlings that spring from the surface buds.

Tribe XVI. Osmundeæ.

Sporangia crowded on the spikelets of contracted branch-like pinnæ or on the veins of the underside of normal ones, shortly stipitate, globose reticulated, splitting vertically on one side when mature into open equal valves, with a rudimentary transverse ring near the apex on the opposite side.

A small tribe consisting of only two genera *Osmunda* and *Todea* which are widely separated in their geographical range, and beyond the agreement in the character of the sporangia, have not much in common in the physiognomy of their general features. One genus is confined to the south temperate zone and the other principally to the north. The rudimentary state of the ring, more globose form, and pedicellate base of the sporangia distinguish this tribe from the next.

Genus XXXVIII. Osmunda, Linn.

Barren and fertile fronds, or portions of fronds, distinct; the former leafy, the latter mere rachises devoid of membrane, both compound; sori on the final ribs in contiguous sub-convolute or lobed spikelets, veins free.

The few species of *Osmunda* have their head quarters and chief range in the north temperate zone, but three or four extend to the equator and one even to the south temperate zone. Two species are found in the West Indies both of which have a wide range both north and south on the mainland. In all cases they are subaquatic or aquatic plants, inhabiting marshes, flooded ditches or shallow ponds, the roots being flooded and the fronds held erect above the water.

Barren and fertile fronds separate.

1. O. cinnamomea.

Fronds fertile at the top; the inferior pinnæ barren.

2. O. regalis.

1. *O. cinnamomea*, Linn.—Rootstock upright or oblique; stipites cæspitose, erect, $\frac{1}{2}$ - $1\frac{1}{4}$ ft. l., flattened at the base, glabrous; barren fronds 1 - $2\frac{1}{4}$ ft. l. $3\frac{1}{2}$-5 in w., bi-pinnatifid, light green; sub-coriaceous the pinnæ numerous, spreading, sub-distant in the lower part, 2 - 3 in. l. $\frac{1}{2}$ - $\frac{5}{8}$ths in. w., sessile and jointed at the base, the apex blunt, deeply cut throughout into rounded segments which are 2 li. w., and rather

more deep; the margins faintly crenulate, the rachis strong, light brown and costæ rather flexuose and tomentose at the base; veins forked; fertile fronds bi-tri-pinnate, the sori abundant occupying completely all the pinnæ; pinnules close, 2-3 li. l. cylindrical; stipites and rachises tomentose.—Pl. Fil. t. 155. Eat. Fer. N. Am. pl. 29.

Infrequent in marshy and wet situations; gathered in Salt Pond, near Guava Ridge, beyond Gordon Town, where it is plentiful in beds of Sphagnum, with *Nephrodium unitum.* Distinguished from other species by the entirely separate barren and fertile fronds.

2. *O. regalis*, G.—Stipites erect, cæspitose from an erect simple or fasciculate rootstock, a foot, more or less l., flattened at the base, brown or stramineous, channelled, naked; fronds erect about as long as the stipites, 4 - 8 or more in. w., bi-pinnate, subcoriaceous, naked, pale green; pinnæ in 2 - serial opposite or sub-opposite pairs, sub-distant, or distant, not sessile, 3 - 5 in. l. $1\frac{1}{2}$ - $2\frac{1}{2}$ in. w, with a distinct terminal segment; pinnulæ opposite or alternate, sessile and rounded at the base, the point obtuse-acute, linear oblong, $\frac{3}{4}$ - $1\frac{1}{2}$ in. l. $\frac{1}{4}$ - $\frac{1}{3}$ in w., broadened or not toward the base; margins faintly serrate; veins free twice forked, close curved, visible; upper pinnæ fertile, divided the same as the barren ones, spikes $\frac{1}{2}$ - $\frac{3}{4}$ in. l., sub-cylindric.—O. spectabilis Willd.

The authority for the Jamaica habitat is taken from a specimen in the British Museum Herbarium collected by Roger Shakespeare in 1777, and there ascribed to Jamaica. Shakespeare collected also on the mainland, where this species is very widely and generally spread, so that the Jamaica habitat may possibly be an error originated in a transposed label; but as it is plentiful in the neighbouring island of Cuba, only the fact that it has not turned up in the close scrunity bestowed by several collectors on the Jamaica ferns during the last half century makes the locality at all doubtful. The tropical state is much dwarfer than the ordinary temperate region one, varying from half to one fourth the size, but the cutting and physiognomy are the same. It is found usually at high elevations.

Tribe XVII. Schizææ.

Sporangia oval or oblong, sessile, attached by the base or side, opening from top to bottom on the outer side, the apex rather contracted striated and crownlike, sori on distinct much contracted branches, or rarely separate fronds, naked or concealed by imbricating scales, or partly by the membranous sub-revolute margin and filamentose scales.

Of the five genera here connected four are represented in tropical America and three of these in the West Indies. In all its primary characters it is an exceedingly distinct Tribe, the sori being generally in contracted panicles or racemose spikes, destitute of membrane, or in marginal fringes. The two genera in which this is not the case are both monotypic, and out of the range of this flora, one being Brasilian and the other African. The sporangia are remarkable for having the ring in the form of a complete crown on the contracted apex..

Fertile appendages terminal on the fronds; capsules attached by the base; bi-or quadri-serial in linear segments, the margins of which at first more or less enclose them.—

1. Schizæa.

Fertile and barren fronds or portions of fronds difform; capsules attached by the base, biserial on the face of naked flattened short ultimate segments.

2. Anemia

Sporangia attached by the side, solitary at the base of shell-shaped imbricating scales, biserial in short 4-gonal marginal spikes.—

3. Lygodium.

Genus XXXIX. Schizæa, Smith.

Fronds with or without a distinct leafy division; fertile portions distinct, borne at the apex of the rachiform frond, or fringe-like, on the excurrent veins along the outer margin of the leaf-blade, pinnate or pedato-digitate the segments linear and costæform, with membranous folded or sub-revolute margins, bearing 2-4 series lengthwise of small crowded capsules, which are attached by the base and have long flexuose ferruginous scales mixed with them.

This is a very peculiar group, generally of a stiff grass or rush-like habit, though two or three possess broad fan-shaped lamina. They grow in shady places or deep forest, two or three of the mainland species sometimes inhabiting, as well, the trunks or branches of trees. About a score of species are known, occupying tropical or warm temperate regions Tropical America and Australia are the chief centres. *S. pusilla*, Pursh, found in the pine barrens of New Jersey, U. S. A., is the only northern species.

Fertile appendages pinnate; sporangia biserial in the segments.
Blade palmate-flabellate.
Blade dichotomously divided.

1. S. elegans.

S. elegans Sw.—Rootstock horizontal, shortly repent, clothed with soft hair-like ferruginous scales; stipites tufted, few or several, erect, strong, channelled, stramineous or light brown above, darker at the base and deciduously scaly-furfuraceous; fronds spreading, fan-like, dichotomously flabellate, 5–10 in. w. 3–6 in. d, the divisions wedge-shape ½–3 in. w., at the truncate outer margin which is erect and often deeply incised, coriaceous, glossy, striated, glabrous; veins free, dichotomously forked; fertile appendages terminal on the incisions of the outer margin, fringe-like, the segments spreading and 10-18 to a side, linear, 2–3 li. l. ¼ li w.; capsules biserial, mixed with undulate castaneous hairs.—Hk. & Gr. Icon. Fil. t. 54.

Gathered by Purdie in 1844, in the Bluefield mountains, Westmoreland, in dry marly woods, at 2,000 ft. altitude. The fronds are the shape of a partly folded fan, but are cut dichotomously into several nearly parallel divisions, the fertile appendages forming a chestnut-brown fringe along the outer margin. It varies greatly in the number and breadth of the divisions of the fronds, and the various forms present a gradual passage so that all might be regarded as varieties of a single plastic type.

Genus XL. Anemia, Swartz.

Barren and fertile parts difform, combined in the same frond or as separate fronds, compound or decompound, the former laminate, the latter rachiform-paniculate; capsules attached by the base, biserial on the face of short flattened ultimate ribs, which they cover, no membrane being present; veins free or united.

These are small plants, from a few inches to a foot or more high, which grow on open or shaded banks, rocks or stony places. In the majority the fertile and sterile divisions are combined on the stem of the same frond, in the others they form separate fronds. There are between thirty and forty species, all of which with a solitary exception belong to tropical America. They possess a striking general family resemblance and to the least observant form a clearly defined group, known in the West Indies, where about one-third of the species belong, as flowering Ferns, in consequence of the paniculate form of the soriferous divisions.

Barren and fertile fronds separate.
1. A. aurita.

Barren and fertile divisions combined in the same frond; the latter paniculate.

Veins areolated.
2. A. Phyllitidis.

Veins free.

Fronds simply pinnate.
3. A. oblongifolia.
4. A. hirta.
5. A. mandiocana.

Fronds simply pinnate, or the pinnæ again lobed or incised.
6. A. Breuteliana.
7. A. filiformis.
8. A. hirsuta.

Fronds bi—or tripinnatifid.
9. A. adiantifolia.

1. A aurita, Swartz.—Stipites subtufted from a shortly repent rootstock, stiff and wiry, 3-6 in l. pubescent; fronds distinct, barren 4-6 in. l. 2-3 in. w., broadest at the base, and bipinnate; pinnæ close, petiolate, with 1-3 pairs of lateral segments and a larger rounded terminal one; rachis channelled, dark pubescent; pinnulæ rounded, the outer subrhomboidal and somewhat lobed, $\frac{1}{4}$-$\frac{1}{2}$ in. or more in diameter, subcoriaceous pellucid, slightly deciduously ciliate, pubescent on the ribs the upper glossy, the margins dentate-crenate; veins forked, flabellate fertile fronds on much longer more slender stipites, the divisions distant, segments soriferous on the upper side, flat, pinnatifid, about 2 li. w. each way.—Hook. Icon. t. 903. *Coptophyllum*, Gard.

On calcareous rocks and dry banks at low elevations and up to 2,000 ft. altitude. All the specimens I have seen were gathered in St. Ann, and the western parishes. The rootstock is clothed with stiff black hairs. There are two or three other species belonging to this section found in the West Indies (in Cuba, Haiti and other islands near), that have not yet been gathered in Jamaica when possibly some of them may exist, endemic.

2. *A. phyllitidis.* Sw.—Rootstock short, upright, fibrous; stipites cæspitose, usually few, erect, ½ - 1 ft. l. slender, light coloured, naked or fibrillose, pubescent; fronds, barren division sessile, simply pinnate, deltoid or oblong-deltoid, widest at the base, ½ - 1 ft. l., 4 - 8 in. w. with a terminal entire or lobed pinnæ and 4 - 9 pairs of spreading lateral ones, which are 2 - 4 in. l, ½ - 1 in. br, cuneate or rounded at the base, thence tapering to the acuminate apex, thin or papyraceous, pale or grey green, slightly fibrillose or pubescent chiefly on the ribs, the margins finely serrated or crenate, veins very oblique, freely areolated, forming long narrow meshes; panicles two on slender stems 4 - 6 in. l. which they equal or exceed, cylindrical, compound, the branches 1 - 4 in. l.—Pl. Fil. t. 156. *Anemedictyon*, J. Smith.

Infrequent on rocks and banks up to 4,000 ft. alt. A larger species than *hirta,* with longer branches to the panicle, and distinguished above all by the areolated venation though in external aspect the two are much alike. Plumier's figures are represented with free veins.

3. *A. oblongifolia.* Sw. Rootstock erect, clothed on the crown with ferruginous tomentum; stipites tufted, slender 1–3 in. l straminous, fibrillose; fronds: barren division 2-4 in. l. 1–1½ in. br. composed of few pairs of patent, oblong, or ovate-oblong opposite, entire pinnæ, which are ½–¾ in. l. 2–3 li. b., obtuse the margins dentate the base cuneate or unequal and obliquely truncate, subcoriaceous, nearly or quite naked or the rachis fibrillose, terminal one border; panicles two, sessile, 1–2 in. l., on every slender petioles, *A humilis,* Sw.

Gathered by Purdie according to Grisebach, probably in central or western parishes. I have only seen Cuban specimen (Wright n. 3933), from which my description is taken. One of the smallest species of genus.

4. *A. hirta,* Sw.—Rootstock small, fibrous, erect, clothed with brown tomentum; stipites tufted, erect usually few, slender, 4—8 in l., fibrillose–pubescent; fronds: barren divisions, sessile, deltoid-oblong, broadest at the base, 3–6 in. l. 2-4 in. b. simply pinnate with a terminal entire or lobed pinnæ 3–8 spreading lateral ones, which are 1–2 in. l., ¼–¾ in. w., cuneate or rounded at the sessile base, thence tapering to the acuminate or acute point, pellucid, papyraceous, light green, slightly pubescent or ciliate on ribs and veins, the margins crenate; veins very oblique, close, fine, repeatedly forked, free; panicles cylindrical 1–3 in. l. on slender pubescent stems, as long or longer, the branches, short and compact. Pl. Fil. t. 157.

Frequent on rocks and banks from the lowlands up to 4,500 ft. alt. It is often confounded with *phyllitidis* from which its generally smaller size and free veins (though an odd pair do casually unite) distinguish it. From *mandiocana* its fewer pinnæ and different shape mark it. Plumier's figure is an excellent representation of the species.

5. *A. mandioeana,* Radd.—Stipites tufted erect, pale brown, pubescent or naked ½-1 ft. l fronds; barren divisions pinnate, chartaceous, gray-green, pubescent or glabresent, oblong-lanceolate, ½-1 ft. l. 2-3½ in. br. composed of a terminal pinnae and 8-12 or more spreading lateral pairs, which are 1-1½ in. l. ⅓-½ in. b. serrulate, the point obtuse-acute the base inequilateral, veins forked, flabellate, oblique, panicle petiolate, reaching to the top of the leaf.—Hook & Grev. Gard. Fer. t. 36,

Jamaica according to Grisebach, who correctly describes it, but I have only been Brasilian specimens. It differs from *phyllitidis* by its

quite free venation, more oblong-lanceolate shape of frond, and more numerous differently shaped pinnae. Plum. Fil. t. 157 quoted by Grisebach does not agree with his description or with the Brasilian plant while it corresponds entirely in shape of frond and pinnae with *phyllitidis* except that, as previously mentioned, the veins are shown as free.

6. *A. Breuteliana*, Presl—Stipites tufted from a small upright rootstock, slender, slightly tomentose light coloured, 3-6 in. l.; fronds: barren division or sessile, oblong-lanceolate, broadest at the base, pinnate, 2½-6 in. l. 1¼-3 in w. the rachis slender, pale brown, tomentose-fibrillose; pinnae 6-10 to a side, with their own width or more between them, spreading obliquely, cuneate at the base, the point subacute or bluntish, ¾-1-¾ in. l. 2-6 li. b., the upper ones entire, the lower with one or two incisions on one or both sides; thin and papyraceous, pellucid, gray-green, more or less ciliate, margins finely serrated; veins very close and oblique, forked, no distinct midrib only at the base of the larger pinnae panicles two, ½ or ¾ as long as their slender stipites shortly branched and linear.—*A. mandiocana*, Hook. Gen. Fil. t. 90.

Infrequent on rocks and wayside banks from 1,000 - 3,000 ft. altitude or higher. It has somewhat the aspect of a weaker state of *hirta*, with the lower pinnæ somewhat incised. The pinnæ however are less pointed, rather more numerous, and more gradually decrescent from the base to the pinnatifid apex than in that species. The veins casually unite.

7. *A filiformis*, Presl.—Rootstock short densely rusty-tomentose stipites tufted, ½ - 1 in. l., rusty-tomentose, fronds: barren division sessile, 1½ - 4 or 5 in. l., ½ - over 1 in. b., simply pinnate; pinnæ with once or twice their own width between them, 1½ - 3 li. w., ¼ - ¾ in. l., sessile and cuneate at the base, rounded and slightly broadened at the apex, firm, rachis and general surfaces especially the under sides rusty-tomentose; margins irregularly toothed or incised; veins fine, close, forked, spreading, no distinct midrib; panicle single, on a slender stem as long as the sterile division, which it overtops by 1 - 3 in.—*A. humilis*, Swartz.

This was gathered by Purdie, but no locality is marked with his specimens which are in the Kew Herbarium. It is nearest in relation to *hirsuta*, from which it may be at once known by the single fertile division and the very short stipites.

8. *A. hirsuta*, Swartz. Rootstock small, fibrous, densely clothed with pale brown tomentum; stipites tufted, slender, erect, stramineous, very slightly scaly, 2–6 or 10 in. l.; fronds: barren divisions sessile, oblong or oblong-lanceolate, 1½–4 in. l. ¾–1½ or 2 in. w., broadest at the base, and bipinnatifid, decrescent to the apex, rachis straw coloured, slender, scaly; pinnæ spreading, apart, ⅓rd 1 in. l. 2–6 li. w. 5–10 to a side, sessile, toothed at the rounded point, both sides deeply cut into narrow segments, which also are toothed on their blunt outer edge, papyraceous, pellucid, gray-green, striated, finely scaly; veins fine, close, forked spreading no distinct midrib, panicles two, compact ½ –1½ in. l. oblong or linear oblong, on long slender petioles which considerably over-tops the leaf.—Pl. Fil. t. 162. Sl. Hist. t. 25. f. 6. Herb. 39. *A. dissecta*, Presl.

Abundant, on rocks and banks from the lowlands up to 5,000 ft. altitude. This is probably the commonest species. It is well marked by its long petioles, small much dissected fronds and short considerably elevated spikes; small specimens are much less cut than the larger ones.

9. *A. adiantifolia*, Swartz.—Rootstock slender, creeping dark tomen-

tose; stipites erect, $\frac{1}{2}$ - 1 ft. l. scaly or naked; fronds, barren divisions deltoid, usually petiolate, very variable in size, from 1 in. to a foot each way. bi-tripinnate; pinnæ lanceolate, stipitate gradually reduced from the basal pair to the apex of the frond; tertiary segments (secondary in the smaller states) ovate or obovate, cuneate at the base, the outer edge dentate entire or lobed, chartaceous; striated, the upper side glossy, slightly ciliate beneath, the rachis, costæ &c., more so; veins fine, close, forked, spreading; panicles two, branches open or spreading, close or distant, petioles as long or shorter.—Pl. Fil. t. 158. Sl. Herb p. 38. Eat. Fer. N. Am. Pl. 15. *A. asplenifolia*, Swartz, Hook and Grev. Icon. t. 16.

Abundant on open banks and rocks in the lowlands and among the lower hills reaching 3,000 ft. altitude. It is exceedingly variable in size and consequently in cutting, some fully fertile fronds being hardly more than an inch each way, while the largest are nearly a foot. In some specimens the fertile fronds are distinct from the barren, as in *coptophyllum* but with normal fronds on the same rootstock and in others the lower pinnæ are contracted and fertile, the upper remaining leafy, combining both states in one leaf. Usually the barren division is petioled above the point from which the fertile branches spring, but the character is only constant in large fronds.

Genus XLI. *Lygodium*, Sw.

Sporangia attached by the side, lying singly at the base of shell-shaped biserial imbricating indusæform scales on the back of oblong or linear spikes which terminate the excurrent veins and form a fringe along the margins; barren and fertile pinnæ leafy, but the latter usually somewhat narrowed in the pinnules; veins free or united; fronds flexuose turning.

This is a peculiar genus, the fronds having slender turning stems which ascend often 20–30 feet on trees, with distant barren pinnæ below, and fertile ones at the top either palmately or pinnately divided. There are between twenty and thirty known species, widely diffused round the world, but mostly within the tropical belt.

Inferior pinnules usually auricled or lobed at the base, rarely all, entire.

1. L. volubile.

Pinnules generally auricled or lobed at the base surfaces pubescent.

2. L. venustum.

1. *L. volubile*, Swartz.—Rootstock short, with strong, wiry descending roots, and densely clothed with minute black glossy scales, stipites tufted, erect, straight, 2 ft. or more l.; fronds several or many feet l., twining, bi-tripinnate; pinnae opposite, spreading, freely petiolate, composed of 3–4 alternate, linear-oblong spreading pinnules, which are subcoriaceous, glabrous, bright green, 3–4 in. l. $\frac{1}{2}$–$\frac{3}{4}$ in. w. subcuneate, cordate or truncate at the base and jointed at the top of the $\frac{1}{4}$–$\frac{1}{2}$ in. l., petioles, which, with the slender, stramineous, flexuose costae are slightly margined and faintly puberulous-pubescent, entire, or auricled lobed or with a short pair of spreading pedicillate pinnae at the base, the apex generally obtuse; veins conspicuous, free, 2–3 times forked, very oblique; spikes contiguous, 30–40 to a side $\frac{1}{8}$th–$\frac{1}{2}$ in. l. the scales 5–20 in a series. Sl. Hist. t. 46 f. 1. *Ophioglossum*, Linn.

Plentiful from the lowlands up to 4,000 ft. altitude, twining and ascending trees 20–30 ft. high ; variable in the length of the sporangiferous spikes, and in the presence or absence of the pair of auricles, lobes or segments at the base of pinnules, which however are usually more or less developed in the basal pair, and often petiolate. In this character it shows close affinity with *venustum.*

2. *L. venustum,* Swartz. Rootstock short, clothed with dark tomentum : stipites tufted, slender erect 1–2 ft. l. brownish ; fronds bitripinnate, twining several or many feet high, pellucid, chartaceous, light green, pubescent, the rachis flexuose ; pinnæ in numerous opposite subdistant pairs, petioled, with a terminal pinnule and several (4–7) alternate spreading lateral ones $1\frac{1}{2}$–4 or 5 in. l. $\frac{1}{3}$rd–$\frac{1}{2}$ in. w. stipitate, the base cordate and expanded on each side into auricles, furcate lobes, or fully separate pinnules, margines serrulate ; costæ straight or flexuose, light brown or stramineous, margined on the face, pubescent ; veins repeatedly forked, or fascicled, evident ; spikes not numerous, generally confined to the inner half or two-thirds of the pinnule, surrounding the auricles, but occasionally reaching nearly to the end, 1–5 li. l. pubescent ; 4–16 in a series.—Pl. Fil. t. 92. Sl. Herb. p. 100. *L. polymorphum* H. B. K. *Ophioglossum scandens,* Linn.

Much less common than *volubile,* gathered in the Spanish Town districts. It is distinguished by the generally pubescent surfaces, narower and more numerous pinnules, with a distinct terminal one, nearly all of which are much expanded hastately the auricles with a furcate tendency. The barren pinnules are often tripartite the central segment much the longest, and the lateral ones furcate.

ADDITONS AND CONTRIBUTONS.

May.

Library.

Botanical Magazine. May [Purchased.]
British Trade Journal. May. [Editor.]
Chemist & Druggist. Apr. 9 to 30. [Editor.]
Garden. Apr. 9 to 30. [Purchased.]
Hooker's Icones Plantarum. Apr. [Bentham Trustees.]
Journal of Botany. May. [Purchased.]
Journal, Royal Horticultural Society.
Journal, R. Colonial Institute. Report for 1897.
Nature. Apr. 7 to 28. [Editor.]
Pharmaceutical Journal. Apr. 9 to 30. [Editor.]
Sugar. Apr. 15. [Editor.]
Sugar Cane. May [Editor.]
W. I. & Com. Advertiser. May. [Editor.]
Sucrerie Indigène et Coloniale. Apr. 12, 18, 26. May. 3. [Editor.]
Tropenpflanzer. May. [Editor.]
Palermo Bol. Ort. Bot. Dec. 1897.
Bulletin de L'Herbier Boissier. May. [Conservateur.]
Algologiska Bidrag. Uebereinige Algen aus Cuba, Jamaica, Puerto-Rico. Bot. Notis. 1887. Af. G. Lagerheim.
Agr. Ledger. 1897. No. 19. [Supt. Govt. Print. Calcutta.]
Madras, Agr. Hort. Soc. Oct.–Dec. 1897. [Superintendent.]
Times of Ceylon. Mar. 17–31. Apr. 6. 14. [Editor.]
Tropical Agriculturist. Apr.
Queensland Agr. Journal. Mar. [Secy. Agr.]
Sugar Journal. Mar. 15. [Editor.]
Cape of G. Hope. Agr. Journal. Mar. 17–31.

Central African Times. Feb. 5–26. Mar. 5. [Editor.]
Maritius Revue Agricole. Feb. [Editor.]
Report of Bot. Gardens in Africa. 1897. [Curator.]
Reports of Bot. Garden B. Guiana 1896–1897. [Editor.]
Bot. Gard. Bulletin. Trinidad. Apr.
Report Govt. Stock Farm. 1897. [Director.]
American Journ. Pharmacy. May. [Editor.]
Torrey Club, Bulletin. May.
Contribution from Gray Herb. of Harvard Uni. Cambridge. Mass.
Bulletins of Exp. St. :—

Kansas	Massachusetts	Montana
Maryland	Michigan	Morgantown
		New Jersey

Bot. Gar. Rio Janeiro. Palmae Mattogrossenses. [Director.]
Industria Agricola. Apr. No. 1.
Montreal Pharm. Journal.
Hawaiian Planter's Monthly. Apr. [Editor.]

Seeds.

From State Gardens, Baroda.

Acacia alta
Agati grandiflora
Albizzia lebbek
Azadirachta indica
Bauhinia purpurea
Casuarina sp.
Clerodendron viscosum
Crescentia cujete
Duranta white
Ehretia aspera
Erythrina indica
E. speciosa
Gauzuma tomentosa
Guatteria longiflolia
Ixora brachiata
Nauclea Cadamba
Nephelium Lit-chi
Nyctanthes Arbor-tristis
Phœnix dactylifera
Putranjiva Roxburghii
Sapindus sapenaria
Santalum album
Streblus asper
Tamarindus indica
Tectona grandis
Tecoma stans
Terminalia belerica
" catappa
Thespesia populnea
Ulmus integrifolia
Wrightia tinctoria

From Botanic Station, British Honduras.

Tabebuia pentaphylla

From Botanic Garden, Ootacamund.

Exacum bicolor

From Mr. J. Gillet, Congo Free State.

Musa (2 spp.)

Bulbs.

From Botanic Gardens, Ootacamund.

Lilium neilgherrense

June.

Library.

Bulletin, Kew Gardens, Dec. 1897. Jan. Feb. & Mar. 1898. [Director.]
Chemist & Druggist. May 7–28. [Editor.]
Garden. May 7–28. [Purchased.]
Gardens' Chronicle. Apr. 28. [Purchased.]
Journ R. Colonial Institute, May. [Secy.]
Nature. May 5–26. [Purchased.]
Pharmacutical Journal. May 7–28. [Editor.]
Produce World. May 6. [Editor.]
Sugar. May 15. [Editor.]
Sugar Cane. June 1. [Editor.]
W. I. & Com. Advertiser. June. [Editor.]
Memo. Purchase in Europe of Carrot Seed for Famine Relief in N. India. Sir G. Birdwell, M. D. 1896.
Sucrerie Indigene et Coloniale. May 10–24. [Editor.]

Tropenpflanzer. June. [Editor.]
Bulletin de l'Herbier Boissier. June. [Conservateur.]
Times of Ceylon. Apr. 20. 28 May 5. 12.
Trop. Agriculturist. May. [Purchased.]
Agr. Gazette. N. S. Wales. Mar. Apr. 28. [Dept. of Agr.]
Queensland Agr. Journal. Apr. [Secy. Agr.]
Botany F. Manson Bailey. Ext. Queenland Agr. Journ. Vol. 1. Pt. 6. [Author.]
Sugar Journal. Apr. 15. [Editor.]
Cape of G. Hope Agr. Journ. [Editor.]
Central African Times. Mar. 12–26. Apr. 2 & 9. [Editor.]
Manritius Revue Agricole. Mar. [Editor.]
Jamaica Agr. Socy. Journal. June. [Secy.]
Report Bot. Garden, Trinidad. 1897. [Supt].
Proc. Agr. Society, Trinidad. Apr. 12. [Secy.]
Antigua Report on Exp. Fields 1897. [Superintendent.]
Montreal Pharm. Journ. June. [Editor.]
Exp. Stations Records. 8. 9. 10. [U. S. Dept. Agr.]
Botanical Gazette. May. [Editor.]
American Journ. Pharmacy. June. [Editor.]
Torry Club Bulletin. June. [Editor.]
Year book U. S. Dept. Agr. 1897. [Dept.]
Report Fruit Exp. Station, Ontario. 1897. [Director.]
Report Fruit Growers Association, Ontario. 1897.
Report Entomological Society, Ontario. 1897.
Hawaiian Planter's Monthly. May. [Editor.]
Bulletins of Exp. St. :—

Arkansas	Missouri	Ottawa
Geneva	New Hampshire	Oregon
Indianopolis	North Dakota	Texas
Maryland	Ontario	Wyomlng

Seeds.

From Botanic Garden, Demerara.
Castilloa elastica
From Royal Botanic Garden, Shibpure.
Ficus altissima
From Botanic Garden, British Guiana
Castilloa elastica
From Dr. Franceschi, California.
Swietenia Mahagoni
From Mrs. Sullivan, Halfway Tree.
African Plant

Plants.

From W. Jekyll, Esq., Robertsfield.
Coreopsis
Lobelia cordinalis
L. erinus

Bulbs.

From Botanic Gardens, Durban.
Begonia geranioides
Nerine flexuosa
N. pancratioides

July.

Library.

Annals of Botany. June. [Purchased.]
Botanical Magazine. June & July. [Purchased.]
British Trade Journal. June & July. [Editor.]
Bulletin, Kew Gardens. Apr. May & June. [Kew.]
Pamphlets. [Kew.]

Chemist and Druggist. June & July. [Editor.]
Garden 4. 11. 18. June 2, 9 July. [Purchased.]
Journal Board of Agri., England. June. [Secy.]
Leaflets of Board of Agri., England. Nos. 41, 46–49. [Secy.]
Journal of Botany. June & July. [Purchased.]
Journal R. Hort. Society. June.
Nature. 2, 9, 16, 23 & 30 June, 7 July. [Purchased.]
Pharmaceutical Journal. June & July.
Produce World. June & July. [Editor.]
Sugar. June. [Editor.]
W. Indian & Com. Advertiser. July. [Editor.]
Sucrerie, Indigène et Coloniale. May, June & July. [Editor.]
Agricultural Ledger, Nos. 18 & 20. [Govt. Printer, Calcutta.]
Times of Ceylon. 18, 26 May. 1, 9, 16, 23 June.
Reports of Agricultural Stations, Java. 1898.
Agricultural Gazette of N. S. Wales. May & June. [Dept. of Agri.]
Queensland Agri. Journal. May & June. [Secy. of Agrl.]
Sugar Journal. May & July. [Editor.]
Report Botanical Station, Lagos. 1897. [Editor.]
Cape of Good Hope, Agri. Journal. May & June. [Agri. Dept.]
Central African Times. April & May. [Editor.]
Mauritius, Revue Agricole. May. [Editor.]
Barbados, Agri. Gazette. Apr. Editor.]
Journal, Jamaica Agricultural Society. July. [Secretary.]
R. Bot. Garden, Bulletin, Trinidad. July. [Superintendent.]
Proc. of Agri. Soc. June. [Secretary.

Publications of the following Agr. Exp Stations U. S. A.

Kansas	Michigan	New Jersey
Kentucky	Minnesota	Vermont
		Virginia

Bulletin Bot. Garden, New York, July. [Director.]
Botanical Gazette. June.]Editor.]
American Journal of Pharmacy. July. [Editor.]
Bulletin, Torrey Club. July. [Editor.]
St. Louis, Trans. of Acad. June.]Editor.]
Minnesota Botanical Studies. [Editor.]
Report Philadelphia College of Pharmacy. 1898.

Seeds.

From Royal Gardens, Kew.
Nepal capsicums
From Botanic Gardens, British Guiana.
Cucumber variety
From Botanic Gavdens, Calcutta.
Sterculia alata.
From R. Botanic Gardens, Trinidad.
Livistona altissima
From Mr. Esme Howard (through Trinidad Gardens).
Widringtonia Whytei.
From Mr. H. Dixson, Sydney.
Archontophœnix Cunninghamii
A. Alexandræ
Macrozamia Hopei
" Pauls-gulielmi
" Moorei

Plants.

From Mrs. Gosset, Halberstadt.
Zephyranthes tubispatha (bulbs).

[Issued 12th Sept., 1898.]

New Series.] AUGUST, 1898. Vol. V. Part 8.

BULLETIN

OF THE

BOTANICAL DEPARTMENT, JAMAICA.

EDITED BY

WILLIAM FAWCETT, B.Sc., F.L.S.

Director of Public Gardens and Plantations.

CONTENTS:

PRICE—Threepence.

A Copy will be supplied free to any Resident in Jamaica, who will send Name and Address to the Director of Public Gardens and Plantations, Kingston P.O.

KINGSTON, JAMAICA:
GOVERNMENT PRINTING OFFICE, 79 DUKE STREET.

1898.

JAMAICA.

BULLETIN

OF THE

BOTANICAL DEPARTMENT.

New Series.] AUGUST, 1898. Vol. V. Part 8.

AGRICULTURE OF THE SUGAR CANE.—II.

Extracts from "Sugar Cane, Vol. 1." by DR. WILLIAM STUBBS, Director of the Louisiana Sugar Experiment Station.

Edited by FRANCIS WATTS, Government Chemist, Jamaica.

MANURIAL REQUIREMENTS OF SUGAR CANE.

Commercial fertilisers are valued chiefly for one or more of the following ingredients: Nitrogen (ammonia), phosphoric acid, and potash. They should be used whenever crops are grown which do not attain their maximum production on account of a deficiency in the soil of one or more of the above ingredients. But the deficiency of plant food is not always the cause of small returns. Water, as already remarked, so essential to crops and needed sometimes in great abundance, is frequently, on our soils, and in this climate, productive of great harm. Hence drainage for its speedy removal is absolutely essential. A drought, on the other hand, may call for irrigation. Want of porosity so common to our black lands, seriously impedes root development.

Some soils bake or cake after very hard rain, and thus by excluding the air and checking evaporation, work disaster to the plant. A great defect with many of our sugar soils is the impermeability of surface water, forming, unless high ridges with deeply ploughed middles prevent, stagnant water at or near the surface, which brings disaster and sometimes death to a rapidly developing plant.

Humus, so essential to every soil in this climate, is frequently badly needed.

Climatic conditions of a purely local character may temporarily prevail, such as alternations of temperature, hot, parching winds, as in south-western Kansas, often destroying a crop in a few days.

It may therefore be asserted that whenever a soil from a physical, chemical or climatic defect, forbids the growth of large crops, even when well supplied with fertilizing ingredients then the application of commercial fertilizers is a waste. The amelioration of its environ-

ments is now more needed by the plant than manures. It is better to seek a remedy in drainage, irrigation, deep ploughing, better cultivation, harrowing, hoeing, incorporation of vegetable matter, etc. After these ameliorating conditions are established, then, and not till then, should a liberal use of fertilisers be practised. It must be remembered that every improvement in the quality of the soil increases its capacity for absorbing large quantities of manure and its transmutation into maximum crops. Heavy plant growth and excellent soil culture mean an enormous conversion of plant food into crops. Where the largest crops are produced there will be the heaviest demand for manure. Hence rich soils can succesfully appropriate heavy applications of fertilisers, while poor soils must be fed with great care. Perfect all the other conditions of heavy plant growth, and then there will be a demand for commercial fertilisers, not a demand to appease hunger, but one to fatten. In fattening domestic animals, all of the conditions of digestion are first perfected, and then they are given all they will eat, not what they need. The object is to transform a larger amount of plant food into fat and muscles within the animal's frame than is required for its maintenance, and this is accomplished by a carefully compounded ration, known to be digestible and palatable. So in farming, whenever practicable, plants of known capacity for absorbing fertilisers should be cultivated, and then these plants should be stimulated to a most intensive assimilation of plant food by the application of suitable manures. While the better class of soils always respond more liberally to fertilisers than poorer ones, still the latter, under favourable conditions, often yield remarkable results. Great care should be exercised to see that the favourable conditions are fully attained, and unless they are, very unsatisfactory results may follow the use of commercial fertilisers. Sometimes the use of fertilisers overcomes the unfavourable surroundings. They cause a larger and deeper root development in early growth and thus enable the plant to withstand a subsequent drought. They frequently cause an early shading of the ground, thus preventing surface hardening and encouraging nitrification, and with the sugar planter enabling him to give an early " lay by" to his crop.

These brief remarks are made to suggest to some planters the cause of their failures sometimes in the use of commercial fertilisers. They may ascribe the failure to the worthlessness of the fertiliser used when it should be ascribed to some defective quality of the soil, rendering it incapable of appropriating the applied fertiliser. (1)

An examination of the cane plant by Prof. Ross revealed the fact that for each ton of cane removed from our soil, with the tops and leaves left in the field which are subsequently burnt, there are removed 3.4 pounds nitrogen, 1.48 pounds phosphoric acid and 2.17

---

(1) The tendency to imagine that short crops are, as a rule, due to deficiencies of plant food in the soil which can be remedied by the application of artificial manures, is a most common one. It is very desirable that every one who is interested in the use of artificial manures should thoroughly understand these points with which Dr. Stubbs wisely prefaces his remarks on the manurial requirements of the sugar cane, for unless this is the case, there can be no intelligent use of this valuable, but somewhat expensive, aid to modern agriculture. The use of artificial manures renders desirable increased care in cultivation, weeding, draining and similar operations.—F. W.

pounds potash. A crop of thirty tons will therefore remove about 102 pounds nitrogen, 45 pounds phosphoric acid, and 65 pounds potash. How much of these ingredients are supplied by our soil? This question can only be answered by experiments. For twelve years the Sugar Experiment Station has tried to solve this problem by a series of systematic experiments.(2) Three permanent plats have been dedicated to replies to this question, known respectively as the nitrogen, phosphoric acid and potash plats. These plats have been divided into twenty experiments, and the question asked of the

NITROGEN PLAT

is: "Does this soil need nitrogen to grow cane successfully?" "If so. what forms of nitrogen are best adapted to the wants of cane and soil, and in what quantities shall they be supplied? The forms of nitrogen used were Nitrate of Soda, Sulphate of Ammonia, Cotton Seed Meal, Dried Blood, Fish Scrap, and Tankage. These were used in such quantities as to furnish twenty-four and forty-eight pounds nitrogen per acre, former experiments having demonstrated that larger quantities could not be appropriated in our average season. These forms were used alone, and combined with excessive quantities of phosphoric acid and potash in highly available forms. At regular intervals through the plat there were left experiments unfertilized to test the natural fertility of the soil, and to each group of nitrogen experiments was attached one containing only phosphoric acid and potash. These experiments have been conducted on this plat for eight years and will be continued indefinitely in the future. The results up to date show conclusively, that this soil needs nitrogen to grow cane successfully, and while sulphate of ammonia has shown annually slightly better results, the high cost gives no advantage over the lower priced forms. Cotton seed meal comes next to the sulphate of ammonia, followed closely by dried blood and nitrate of soda. Fish scrap and tankage are slightly behind the rest, for reasons assigned below.

It has been found also that but very few of our seasons give us rainfalls in quantity and distribution sufficient to enable the cane plant to appropriate 48 pounds of nitrogen. Hence a larger quantity is excessive, and it may be a waste. It is therefore safe to recommend quantities of nitrogen varying between 24 and 48 pounds per acre for our cane crop. Again, different soils and different kinds of cane require varying quantities of nitrogen. Plant cane upon pea vine land, will not require the same amount as upon "succession" land, i.e., upon soils

(2) Field experiments are absolutely necessary in order to answer questions of this kind. It is a mistake to suppose that analytical investigations of the soil can supply the answer. Chemical analysis can indicate broadly the character of a soil and show what elements of plant food are present in large or in deficient quantities, but it is impossible by this means to indicate with certainty whether, for instance, it will prove remunerative to apply, say, 40lbs, of potash per acre to a particular soil; nor is this to be wondered at when we remember that an acre of soil to a depth of 12 inches weighs about 5,000,000 pounds, so that 40 lbs of potash would represent ·00008 per cent., and yet the addition of 40 lbs. of potash per acre may result in a large increase in the yield, and that, perhaps, on soil already containing from ·2 to ·5 per cent, or 10,000 to 25,000 pounds of potash, combined in various ways. It is now universally admitted that laboratory investigations must be supplemented by field experiments.—F. W.

from which a crop of stubble cane has just been taken and which has been continuously in cane for years without the intervention of a leguminous crop to restore the nitrogen. Indeed such soils are frequently in an execrable physical condition, which not only precludes the possibility of themselves furnishing plant food, but also prevents them from assimilating much of that presented in the form of commercial fertilisers. Hence the unsatisfactory results from manuring succession canes, so often experienced by planters. It is doubtful whether one-half of the plant food applied to succession canes in commercial fertilisers, is recovered in the canes in the average season.

Pea vine lands put in plant cane, on account of their excellent physical conditions, not only yield up readily the nitrogen stored up by the peas, but can also assimilate large quantities of plant food supplied as fertilisers. Hence such canes usually make large crops.

Since nitrogen is the chief ingredient taken from the soil by a crop of cane, it follows that with each successive crop of cane grown on the land, without the intervention of a restorative leguminous crop, there arises an increased demand for nitrogen. Hence stubble canes require larger quantities than plant cane, and the older the stubble, the larger its requirements for this element to make a given tonnage. ([3]).

EXPLANATION OF THE FORMS OF NITROGEN.

Sulphate of Ammonia, is a by-product in the manufacture of coal gas of cities. It is the recovered nitrogen stored up in the plants which made the coal ages ago. It is the most concentrated form of nitrogen found on our markets, containing 21 pounds in every 100 pounds of salt. It is especially adapted to sugar canes on clayey soils, giving larger returns than any other form. Its high price, however, will always prevent its extensive use. Its present price is from $60.00 to $80.00 per ton. It is used, like nitrate of soda, as a top dressing for small and stunted canes, with most excellent results.

Nitrate of Soda, is a partially refined product from the mines of Chili and Peru, and contains 15 to 16 per cent. of nitrogen. The output of the mines is controlled by a syndicate which regulates its price. Hence its values change but little from year to year, its present price being about $40.00 to $50.00 per ton. It is the most soluble form of nitrogen and should be used with great care to prevent loss. Small quantities at short intervals applied as a top dressing, are frequently used with excellent results on grass lands. It is believed to be too soluble, in this climate of heavy rainfall, for the best results.

The above, sulphate of ammonia and nitrate of soda, are mineral forms of nitrogen.

Of the vegetable forms of nitrogen available to our planters, cotton seed meal is by far the most extensively used. Sometimes a ton or two of castor pomace finds its way to Louisiana, but the aggregate

---

(3) This is practically the universal experience of sugar growers on all kinds of soil. In most places it is impossible to grow ratoons or stubble canes so as to produce 15 or 20 tons of cane per acre without the use of a fertiliser rich in nitrogen. Sulphate of ammonia is the nitrogenous fertiliser which most commends itself to West Indian sugar growers. It is a very concentrated manure, easily applied and readily assimilated by the cane plant.—F. W.

quantity used as a fertiliser in this State is so small that a discussion of its merits may be omitted.

Cotton seed meal is a by-product from the the cotton seed oil mills Cotton seeds are first hulled, and the k ernels, after being steamed, are subjected to hydraulic pressure to remove the oil. This leaves cotton seed cake, which is largely exported for use as a cattle food in England and continental countries. Nearly three-fourths of the products of our mills are thus disposed of. The remainder is consumed in this country, both as food stuff and fertiliser. However for use in this country, the cake is ground into fine meal and sold on our markets as "Cotton Seed Meal." When fresh and free from hulls, it has a bright yellow colour, oily appearance and nutty odour. The presence of comminuted hulls darkens the colour and lowers the percentage of nitrogen. Age and ferments also darken the colour without lowering the content of nitrogen, and therefore cause little or no injury to it for fertilising purposes, but seriously destroy its feeding values converting the nitrogenous matters into poisonous ptomaines.

Cotton seed meal has an average composition of 7 per cent. nitrogen 3 per cent. phosphoric acid and 2 per cent. potash. Being a southern product, the prices paid by our planters may be regarded as initial values, without charges, insurance and freight necessary to place it on the world's markets in competition with other forms of nitrogen. Therefore, it may be asserted that it is to our planters the cheapest form of nitrogen. Occasionally, with low markets elsewhere for fertilising material, tankage, fish scrap, etc., may find purchasers in our midst at prices for its nitrogen content slightly below the prevailing rate for nitrogen in cotton seed meal; but as a rule, the cost of nitrogen in cotton seed meal to our home planters is less than in any other form. Experiments in the laboratory upon the different forms of nitrogen have shown that next to the mineral forms (sulphate of ammonia and nitrate of soda) stand the vegetable, in their order of availability as plant food. Cotton seed meal especially was shown to have a high co efficient of availability. as much as 78 per cent. of its nitrogen having been appropriated directly as plant food the first year.

It is, therefore, extremely gratifying to our planters to know that a home product furnishes them with the cheapest and best form of nitrogen.

The following animal forms of nitrogen are found on our markets :—(1) Dried blood, (2) Tankage and (3) Fish scrap.

Dried blood is a by-product of our slaughter-houses and comes into markets under two heads Red blood and Black blood. The former is dried slowly at a low temperature, and is believed to be slightly more available than black blood which is rapidly dried at high temperatures by steam. Dried blood contains 12 to 16 per cent. of nitrogen, with practically no potash or phosphoric acid. It is the most available of animal forms of nitrogen, ranking in the trials given above, next to cotton seed meal.

Tankage, is a mixture of the refuse of the slaughter-houses and consists of dried blood, pieces of meat, particles of bone, etc., all of which have been rendered to remove the oil or fats, and the residue is then dried and ground into fine powder and sold as tankage.

Tankage must be examined from two standpoints to determine its value as a fertiliser, viz., mechanically and chemically. On account of the bone present as a constant ingredient, a mechanical analysis is always in order, since the availability of bone, slow in its best condition, is believed to be directly as its pulverisation. Fragments of bone, or even coarsely ground bones, are very slow in decomposing. "Too slow in this busy age when every hour must chase its sixty minutes to its death." Therefore, it is of first consideration that all tankage be very finely ground.

Chemically, tankage is a mixture of blood and meat, substances rich in nitrogen, and of bone high in phosphoric acid. Therefore it may vary greatly in composition, between wide extremes; bone with 4 per cent. nitrogen, and 24 per cent. phosphoric acid, and blood with 16 per cent. nitrogen (only). Usually it is sold, as it should be, by chemical analysis only. The higher the nitrogen content, the more valuable the tankage, both in dollars and cents, and in availability in the field, since this high content indicates an excess of dried blood or meat, both highly available forms of nitrogen, over bone, a very slowly available form.

When an analysis of tankage is given, the percentage of bone present may be roughly calculated. Suppose analysis shows 9 per cent. of nitrogen and 9 per cent. phosphoric acid, what part of tankage is bone? Bone contains on an average, 4 per cent. nitrogen and 24 per per cent. phosphoric acid. Therefore, the nitrogen corresponding to the 9 per cent. of phosphoric acid is 1 5 pounds, calculated by following proportion : 24 : 9 :: 4 : x =1.5 pounds. Since there are 9 pounds of nitrogen present, and 1.5 pounds of this adheres to the bone, then 7.5 pounds, or the remainder, comes from the blood and meat. Since 100 pounds of bone contain 24 pounds phosphoric acid and 4 pounds nitrogen therefore, it will require 37.5 pounds of bone to furnish the 1.5 pounds nitrogen and 9 pounds phosphoric acid found in the tankage. Therefore, the tankage consists of 37.5 parts of bone and 62.5 parts of blood and meat scrap.

This example is given to illustrate the difference in values between different grades of tankage and to show that its value as a fertiliser largely depends upon the amount of nitrogen furnished by the blood and meat scrap, and not that supplied by the bone. Tankage is a popular fertiliser with our planters just now, and the difference of opinion prevailing as to its value is doubtless largely due to the difference in composition of the various brands offered on our markets. Low grades are universally unsatisfactory in their results, while high grades frequently give most excellent returns.

Fish Scrap, the dried and ground residue from fish after the oil has been extracted, is used more to ammoniate manipulated fertilisers than as a direct fertiliser in the south. Like tankage, its value depends upon the relative proportion of meat to bone in the fish worked. A part of the nitrogen always present, is inherent in the bone and is therefore not as available as that in the meat. The action then of fish scrap as a fertiliser is necessarily slower than the highly active forms of cotton seed meal and dried blood.

NITRIFICATION.

It must be borne in mind that all of the above fertilisers, save nitrate of soda, must be decomposed and converted into soluble forms before they can be appropriated as plant food This process of conversion is usually denominated as "nitrification."

Nitrification must go on in every cultivated soil in order that plants may grow therein, and the more rapid this nitrification "*ceteris paribus,*" the greater the growth of the plants in a given time. The process of nitrification is accomplished through the work of micro-organisms (bacteria) of which there are three different types: 1st, those which convert nitrogenous matter into ammonia; 2nd, those which convert ammonia into nitrous acid, and 3rd, those which convert nitrous acid into nitric acid. Each of these is necessary to the complete transformation of cotton seed meal, dried blood, tankage, etc., into nitric acid, the form of nitrogen chiefly available as plant food.

It should be the aim of every cultivator to maintain his field in conditions most favourable to the development of these soil ferments, upon whose activity,not only the plant food already in the soil, but also that applied in the form of fertilisers, depend for their solubility. The conditions for the rapid multiplication of these ferments are given in the chapter on cultivation. It will be apparent, however, from the above, that it is a misuse of fertilisers to apply them to soils that have been badly ploughed, imperfectly drained, and in bad tilth. Every planter, before resorting to the use of fertilisers, should see that the soil upon which they are to be applied should be in a condition to aid in the most rapid nitrification possible. Only by the observance of conditions most favourable to nitrification, can the full effects of the applied fertiliser be obtained.(4)

NITROGEN REQUIRED IN A ROTATION.

From investigations made by this station, a crop of cow peas when turned under at the proper time, will add at least 100 pounds of nitrogen per acre, most, if not all of which, it is believed, is gathered from the air. (5). The average crop of plant cane grown upon pea vine land is not far from thirty tons per acre. The first year stubble following this plant, should give twenty tons per acre, and if kept for the second year stubble, a crop of at least 15 tons per acre should be

---

(4) These modern views which regard the soil as a complex workshop, full of living organisms busy preparing nitrogenous matters in order to fit them for the use of plants, have done perhaps more than anything else to place agriculture on a scientific basis; we now know why it is that tillage and drainage are such important factors and why if they are neglected poor crops are obtained even when an abundance of plant food is present in the soil. It will be seen that most agricultural operations are directed towards maintaining the soil in such condition that the nitrifying bacteria may best flourish in it; this being accomplished, good crops may be expected.—F. W.

(5) This use of green dressings is of the first importance to sugar growers. Thi 100 pounds of nitrogen is equal to about 500 pounds of Sulphate of ammonia so that a green dressing in addition to improving the texture of the soil and adding humus to maintain this improved condition, draws from the atmosphere upwards of £3 worth of nitrogen per acre and adds it to the soil in a condition well suited to the requirements of the sugar cane.—F. W.

obtained. The three year cropping would give 65 tons of cane which, together with tops and fodder (which are burned) would remove from the soil 221 pounds nitrogen. Of this amount, 100 pounds would be furnished by the peas, most of which would go to the plant cane, leaving 121 pounds to be supplied by fertilisers in order that the soil may retain the original fertility. It will require over 1,700 pounds of cotton seed meal to supply this quantity of nitrogen, or 970 pounds for first year stubble and 730 pounds for the second year stubble. These quantities are usually in excess of practice, because there is a certain amount of nitrogen furnished by the soil every year, and secondly our crops of pease give frequently larger quantities of nitrogen than given above, and, lastly, such tonnage through three years are rarely obtained. However, this will serve as an illustration of the value of nitrogen to the sugar cane crop.

(*To be continued.*)

SOIL INOCULATION.

By N. H. J. Miller.

Reprinted from Journ. R. Agri. Soc. England, Vol. VII.

Whilst the demonstration, some ten years ago, by Hellriegel and Wilfarth of the fixation of elementary nitrogen during the growth of certain plants bearing nodules on their roots, is undoubtedly one of the most interesting and important of recent discoveries—extending our knowledge of the powers exercised by micro-organisms, showing the element nitrogen in an entirely new light, and explaining, to some extent, the exceptional position in agriculture which our leguminous crops have for centuries been known to occupy—it has seemed to some that the amount of labour devoted to the nitrogen question, interesting as are the results which have been obtained, is out of proportion to the practical benefits likely to be derived from it. The question which concerns agriculturists is whether they will be enabled, by growing leguminous crops, to draw upon the practically unlimited store of atmospheric nitrogen, and thus be less dependent upon the most costly of manures—combined nitrogen, in its different forms.

To Dr. Salfeld, of Lingen, in Hanover, belongs the credit of being the first to put Hellriegel's discovery to a practical test in the field, his earliest experiments in this direction having been made as far back as 1887. And he has recently collected and published (1) the results of his own and of other experiments made in Germany, Austria and Sweden, some of which it is proposed in this paper to notice. But, before doing this, a few words on the present position of the nitrogen question will be useful.

In the first place, it may be stated that the higher chlorophyllous plants, of whatever order, are totally unable, *per se*, to assimilate free nitrogen. Evidence has, it is true, from time to time been adduced in support of nitrogen fixation by individual plants, but such results will

---

1 A. Salfeld, Die Boden-Impfung zu den Pflanzen mit Schmetterlingsbluten im landwirschaftlichen Bertriebe, Bremen, 1896.

frequently bear another interpretation, or, if not, are refuted by the overwhelming amount of evidence against such an assumption furnished by exact experiments, as well as by general experience in agricultural practice. And as even yet the experiments made between forty and fifty years ago by Ville are sometimes quoted as being the first to prove that fixation of nitrogen takes place during the growth of plants, it may be mentioned that some, at any rate, of his results, which showed an enormous gain of nitrogen, are now known to be incorrect. The conditions under which the experiments were made were such as to exclude the action of micro-organisms which are now known to be essential; and fixation of nitrogen by non-leguminous plants in absence of any combined nitrogen is disclaimed even by Frank, who, although he believes that all plants have the power of fixing nitrogen, considers the presence of some combined nitrogen necessary to enable non-leguminous plants to make a start.

At the present time we are acquainted with three processes by which free nitrogen may be brought into combination, and thus rendered available to plants: (1) By atmospheric electricity, (2) by a micro-organism in the soil, (3) by the symbiosis of certain plants and micro-organisms.

1. The amount of nitrogen brought into combination by electricity is very limited, and quite inadequate to the wants of any crop. As it is, moreover, equally available for all crops it need not be specially considered here.

2. As regards fixation in the soil, we include fixation by the micro-organism (Clostridium Pasteurianum) isolated by Winogradsky, (2) and fixation by algae (Schloesing and Laurent), (3) as it seems likely that we have to do with one and the same process. For it must be borne in mind that in Schloesing and Laurent's experiments the algae contained bacteria, and although it is not impossible that Nostoc and some other algae can fix nitrogen, there is, so far, no evidence that algae, in the absence of micro-organisms, have that power. Kossowitsch's experiments (4) with different algae, with and without bacteria, favour the view that it is the bacteria which fix nitrogen when supplied with suitable carbonaceous matter, such as sugar; and that certain gelatinous algae, e.g. Nostoc, take the place of sugar in furnishing the bacteria with carbon. This would account for the fact that some soils, when exposed to light, gain nitrogen, whilst in absence of light they do not. In the first case there is a development of algae, in the second case no algae are formed; and without algae to supply carbon for the bacteria, fixation of nitrogen cannot take place. It is, however, doubtful whether, as has been suggested, we have here to do with a true symbiosis, as in the case of root nodules, which are special organs formed on the roots of the plant under the influence of the bacterium, and in which the bacterium itself undergoes modification. This change in the form of the micro-organism seems to be essential; no appreciable fixation has, at any rate, been observed in pure cultures of the unmodified form.

---

2 Archives des Sciences Biol, 1895, tome 111., p. 279, et. seq.
3 Ann. Inst. Pasteur, tome vi, p. 824. Also Fream, "Fixation of Free Nitrogen by the Lower Green Plants." Journal R.A.S.E, 1892, [3] Vol. 111 p. 427.
4 Bot. Zeitung, 1894, Bd. 52, p. 97.

Although Winogradsky showed that the nitrogen-fixing power of this soil organism, growing in sugar solutions, is very considerable, we are quite in the dark as to the extent to which fixation of nitrogen goes on in the soil—whether it is even in excess of the amount lost by drainage, &c. The greatest gain would presumably be in soils containing plenty of organic matter and on uncultivated and undrained land; the smallest gain if any, would be on ordinary arable land.

Whilst, according to Berthelot, there are a number of soil organisms which fix nitrogen, Winogradsky found only the one referred to which possesses this power; and, although he isolated fourteen other micro-organisms from the soil, none of these fixed nitrogen to an appreciable extent in absence of combined nitrogen, although two of them showed, perhaps. a very slight gain when grown in presence of a small amount of combined nitrogen.

3. It is, then, with the third process, fixation in the root nodules—that we have to deal. It is not necessary here to go into the history of the subject, as that has already been been pretty fully discussed ([5]). That fixation does take place has been confirmed over and over again. The biology of the subject has also received a good deal of attention, important results having been obtained by Marshall Ward—who made clear the process by which the micro-organism invades and enters the root tissues—by Tschirch, Brunchorst, and others. And the relation between the plant and its nodules has, to some extent, been explained by the Rothamsted experiments, in which the growth and ripening of the plant were shown to be coincident with progressive exhaustion of the nitrogenous matter of the nodules whilst on the other hand, with plants not ripe, or of more than annual growth, there was accumulation in the nodules—that is, provision for future growth. ([6]) It must, however, be admitted that we are still completely in the dark as to the nature of the chemical process by which nitrogen is first brought into combination within the nodules, and what is the first compound formed.

As far as agricultural plants are concerned, it is only those of the leguminous sub-order Papilionaceæ on the roots of which nodules occur, and which in consequence can thrive without external application of combined nitrogen. It may, however, be mentioned that the symbosis prevails in the case of other leguminous plants—for instance, of the sub-orders Mimoseæ and Cæsalpinieæ, ([7]) and even of non-leguminous plants such as the common alder. ([8])

The methods employed in pot experiments for inducing the formation of nodules have been the application of a soil extract (Hellriegel), of soil itself (Frank), or the inoculation has been made directly from the contents of a nodule. Hellriegel's earliest results showed that all

---

5 Lawes and Gilbert, Journal R.A.S.E., 1891. [3] Vol. 11., p. 657.

6 Lawes and Gilbert, loc. cit. Also Gilbert, U.S. Agric. Dept. Office of Experiment Stations, Bul. No. 22, p.136, et seq.

7 Morck "Ueber die Formen d. Bakteroiden b. d. einzelnen Spezies d. Legumi nosen." Inaug. Diss. Leipzig, 1891.

8 L. Hiltner, "Ueber d. Bedeutung d. Wurzelknollchen v. Alnus glutinosa f.d. Stickstoffernahrung dieser Pflanze, " Landw. Versuchs-Stat., 1895, Bd. 46, p. 153, and R. Dinger, De els als stikstofverzamelaar. Landbouwnkundig Tijdschrift, 1895, p. 167.

soil extracts are not equally suitable for inoculating certain plants; but the most systematic and conclusive experiments on this part of the subject are those of Nobbe, who concluded that there is only one micro-organism concerned (Beijerinck's Bacillus radicicola), but that it becomes so altered in the symbiosis with certain plants as to be rendered useless for the purpose of infecting others. (9) This is, however, not always the case, since the bacteria from pease and vetches, for instance, seem to be, mutually available. On the other hand, the bacterium as modified by the pea (or vetch) is useless for serradella, robinia, and for red and other varieties of clover Nobbe thinks this may account for the divergent results obtained by different observers, some of whom found lupins, others serradella, &c., to be the greatest nitrogen collector; the difference being in reality, most probably due to the inoculation having been more or less suitable or unsuitable. The importance of this question will be better realised in discussing the results of the field experiments.

FIELD EXPERIMENTS ON SOIL INOCULATION.

The greater portion of the inoculation experiments described by Salfeld were made on peaty soils (Moorland,) and it was at the then new Experiment Station of the Central Moor-Kommission on the Great Bourtanger Moor that the first trials were made in 1887 (i.e. immediately after the announcement of Hellriegel's discovery) when the usual methods of reclaiming the land seemed almost hopeless. It had generally been found possible on old cultivated, peaty soils, which had been manured with dung, to obtain satisfactory crops of horse beans and peas, after the application of quicklime or marl, with kainite and phophates, but on the new land these plants did not thrive unless supplied with nitrogenons manure. The attempt to commence with buckwheat, as a peaty-soil plant, instead of horse-beans, did not meet with success in presence of large quantities of lime (32 cwt. per acre), and it was not advisable to apply less lime on account of the clover.

The first experiments made in 1887, in which horse-beans, grey. Prussian peas, field peas, garden peas, and Ervum monanthos were inoculated by applying soil to the field, afforded clear indications of a favourable character, but as no numerical results are given for the different plots, we will pass on to the second series of experiments, made in 1888.

The land selected had an area of 1 hectare (about 2½ acres). The northern half of the field had been twice burnt, and in 1886 received 32 cwt., of lime per acre. Kalnite, containing 140 lb., of potash, basic slag containing 107 lb., of phosphoric acid, and ammonium sulphate and sodium nitrate, containing together 54 lb., of nitrogen per acre, were applied, and a yield of 18.74 cwt., per acre of winter-rye grain obtained in 1887. In the 1888 experiments the land was divided into eighteen plots, about five yards wide, and separated from each other by a path and a ditch alternately. The plants employed were: (1) Peas, four plots; (2) horse beans mixed with peas, eight plots; (3) horse beans and lentils (Ervum), four plots; (4) Pisum arvens, two plots. The

9 Landw. Versuchs-Stat. 1891. Bd. 39, and 1893, Bd. 42; also Hannov. Land u Forstwirtschaftl. Zeit. 1894, p. 79.

manuring for all the plots was potash (in kainite) 140 lb., phosphoric acid (in basic slag) 107 lb., per acre applied in September, 1887. In October three kinds of inoculating soils were applied, and were worked in to a depth of 4 inches in April 1888.

The plants were damaged by a late frost (May 29), the horse-beans being the least affected. By June 13 a decided effect was visible on the plots inoculated with the two fertile soils, especially the loam, and the peas so treated had a dark green colour, whilst those which were not inoculated were yellowish green. By the end of June the effect of the bean soil was most striking, being visible from a great distance, and was camparable with the effect of 3 cwt. of nitrate of soda per acre on rye, as compared with unmanured rye.

In the table below are stated the particulars as regards the soils applied, and the total produce obtained, under the different conditions. Average results, in pounds per acre are given :—

Inoculating Soil.	Field Peas.		Beans and Pease.		Beans and Lentils.		Peas.	
	Corn.	Straw.	Corn.	Straw.	Corn.	Straw.	Corn.	Straw.
No soil applied ...	791	2,299	615	1,453	283	1,935	327	2,832
Uncultivated ...	—	—	396	1,027	298	2,068	—	--
Arable Loam (beans) ...	496	3,760	1,027	2,728	—	..	—	—
Loamy marsh Soil ...	1,062	4,286	1,171	3,155	873	3,576	387	3,120

An examination of the roots of the plants showed that those grown in inoculated soil were thickly covered with nodules; where there had been no inoculation, nodules were only occasionally found. The increased production, brought about by the application of soil to the land, could only be due to the introduction of appropriate micro-organisms. It could not be owing to the soil being improved physically, since the uncultivated loam was without effect; and the manurial value of the soil applied was practically nothing.

In 1891, an experiment on peaty soil was made with a mixture of grey peas and horse-beans, in which the effects of different soils for inoculation, and of varying amounts of lime were investigated. One portion of the field had been burnt, the other not. The inoculating soils were (1) mud from the Zuider Zee; (2) a sandy soil on which the peas had grown well; and (3) an old very light, sandy lupin soil, The whole field, about $2\frac{1}{2}$ acres had been dug to the depth 10 inches in 1889, harrowed in June 1890, then slaked lime was very carefully distributed over the land, in quantities of 16, 24 and 32 cwt. per acre, and harrowed in. In July the land was forked to a depth of 4 inches, in October to a depth of 8 inches. Kainite (1,070lb. per acre) and basic slag (535 lb.) were sown in November. The inoculating soils were applied the following April, and were well harrowed in before the seed was sown. The seeds were covered over by harrowing. By May 26 leaves were formed on the young plants, but no difference was perceptible between the plots. On June 13 the plants which received the greatest amount of lime (32

cwt. per acre) were satisfactory, the others less so; and as yet there was no decided effect from inoculation. By July 7 the plants, except those inoculated with peasoil, where mostly yellow and unhealthy looking, and generally no nodules were to be found on their roots; only a few of them were normally developed, and these had nodules. On the other hand, the plants, both beans and peas, growing on the plots inoculated with pea soil were strong, dark green, and healthy generally; all of them had numerous nodules on their roots.

The effect of inoculation with pea soil was more marked on the burnt portion of the field than on the other. On the unburnt plots the number of stronger plants (beans and peas) increased (July 14) where no peat soil, but 32 cwt.. of lime per acre, had been applied; but the majority of the plants on these plots remained yellow, and without nodule formation.

On July 28 the relative differences remained the same for the different plots. Towards the end of August the horse beans were all attacked by rust, seed production being thus much hindered, and the plants had to be harvested before ripe, so as not to damage the next crop (winter-rye). The weather had been very wet, but the delay in ripening may have also beten due to the symbiosis, which would be in accordance with observations made by Hellriegel and by Nobbe.

The table below gives the total produce, generally averages of two or more plots.

Lime applied cwt. per acre.	Inoculating soil.	Produce (lb.) on burnt soil.	Produce (lb.) on soil not burnt.
32	Not inoculated	103.14	166.59
24	" "	——	111.72
16	" "	——	48.69
32	Pea sandy soil	237.14	255.02
24	" "	——	220.14
16	" "	——	97.15
32	sea mud	76.84	——
32	lupin soil	96.49	——

The results show that in absence of stable manure, peaty soil poor in nitrogen, and not containing the micro-organisms necessary to enable leguminous plants to utilise free nitrogen, may be cultivated after inoculating with a suitable soil in the quantity of 16 cwt. per acre, such inoculation being more essential and more productive of good results, in freshly burnt soils, than on land which has not been recently burnt. The selection of suitable soil for inoculation is again shown to be of great importance, lupin soil being, in these experiments, useless when applied for peas and beans. Finally, the presence of sufficient lime is clearly shown to be essential for the production of a good crop. Applications of 16 cwt. per acre were quite insufficient, and better results were obtained with 32 cwt. than with 24 cwt. per acre on the peaty soil on which these experiments were made.

After the harvest, another field was inoculated by means of some of the surface soil of the successful plots (i.e. those which had received pea soil), and peas and beans were sown in it. The plants developed well,

but were destroyed by a late frost. The next year (1893), however, after manuring with lime (32 cwt.) keinite (8 cwt.) and basic slag (2.4 cwt. per acre), the following amounts of beans and pease were obtained per acre:—

		Corn. cwt.	Straw. cwt.
Horse-beans	...	11.4	23.7
Peas	...	12.5	27 8
	Total	23.9	51.5

These results are interesting, as they were obtained by inoculating from the recently inoculated peaty soil.

Similar results were obtained by Dr. C. von Feilitzen on the raw, peaty soil of Jönköping, in Sweden. In experiments with peas he obtained an increase of 105 per cent. of corn and 23 per cent. of straw, and the corn was much better developed under the influence of inoculation.

Some very interesting results were obtain in experiments on laying a field down to grass. The land selected for this purpose was again peaty soil which had been burnt, and on which buckwheat had been grown without manure. It had then been left for about five years, and had produced but little vegetation, mainly Holcus mollis, Molinia caerulea and rushes. In 1887, kainite, and basic slag, were applied and buckwheat sown. Slaked lime (32 cwt. per acre) was very carefully spread over the field and worked into the soil to a depth of five inches, after which kainite and basic slag were applied, along with marshy soil for inoculation. There were twenty plots, which received, in groups of four, 32, 24, 16, and 8 cwt., of soil respectively, whilst those of the fifth group were not inoculated. In April, 1889, oats were sown, receiving 170 lb. of nitrate of soda per acre. In May, clover and grass were sown in the following amounts per acre:—

		lb. per acre.
Trifolium pratense	...	0.4
" hybridium	...	0.8
" repens	...	1.2
Lotus corniculatus	...	6.1
Grass ...	...	33.4

The oats grew well all over the field, but were, of course, not in the least influenced by inoculation. When, however, the oats were cut the favourable effect of the marshy soil on the clover was very marked, whilst without inoculation the plants were generally feebly developed, and there were many gaps. With the smallest amount of inoculating soil (8 cwt. per acre) the clover was more dense, and of a much darker green colour, than where no soil had been applied; and on the roots of the plants nodules were abundant. The luxuriance of the clover increased with the amount of marshy soil applied, but the differences with the various amounts of soil are not to be compared with the effect of the smallest qnantity as compared with the uninoculated plots. It is proposed, in future, to apply 16 cwt. of soil per acre to other fields. For the field on which the above experiments were made it will only

be necessary to manure with potash and phosphates. In 1890 the yield of clover-grass hay was 3 tons 7 cwt. per acre, and was of the best quality.

We will mention one more experiment made on new peaty soil, namely, with serradella (Ornithopus sativus), not so much on account of the legiminous crop itself, which is not grown in England, as for the effect produced on a subsequent crop of potatoes by ploughing it in. After an application of lime (32 cwt. per acre), rye, potatoes, and again rye, were grown in 1889-91, the land being, each year, manured with kainite, basic slag, and sodium nitrate. The results were, however, unsatisfactory when the amounts of manure given are considered, owing to the nitrogenous matter of the soil having been dissipated by frequent burning. In 1891 the land was divided into ten plots of about 0.25 acre each, and carefully manured and limed; plots 1, 2, and 3 received 8 cwt. of soil per acre from a serradella field, and after rye was sown the whole of the field was harrowed. Serradella was then (May) sown on plots 1 to 6. The rye grew uniformly over the whole field. The serradella germinated well, but failed on the plots which were not inoculated, whilst on the inoculated plots it was most luxuriant. In October samples of the serradella were taken, after which the rest was ploughed in. The yield of serradella was estimated at 7 tons 4.25 cwt. per acre green: this, when ploughed in, corresponds with a dressing of 3.2 cwt. of nitrate of soda per acre. In 1893 potatoes were sown, being manured with dung (about 10 tons per acre) and artificial mauures, on all the plots. The following quantities of potatoes were obtained per acre with and without the green manuring:—

		tons	cwt.	qrts.
without green manuring	...	6	10	3
with " "	...	8	7	2

In the case of rye, which followed the potatoes, there was also a considerable gain, both in grain and in straw, due to the green manuring, after inoculation. The profit[10] per acre, due to inoculation, in the years 1893 and 1894 was as follows:—

		£	s.	d.
In 1893, an excess of 1 ton 16 cwt. 3 qrs. of potatoes per acre	...	3	12	10
In 1894, saving of 0.8 cwt. nitrate of soda per acre	...	0	7	1
" an excess of rye grain—2.9 cwt.	...	0	16	7
" " straw—2.8	...	0	4	2
Total	...	5	0	8

Tho soil of the field was employed for inoculating other land intended for serradella. The green manuring rendered a heavy application of stable manure unnecessary for potatoes, and it will probably be possible to limit the number of cattle kept, and the growth of fodder crops, much more than was hitherto thought possible.

Let us next proceed to consider some results obtained on sandy soils. In 1890 a field near Lingen was selected for experiment. It was a

10 The serradella seed, 36lb. per acre, cost about £1.

poor sandy soil, thinly, but uniformly, covered with heather. In November, kainite and basic slag were sown all over the field, and in May 1891, a strip about eleven yards wide and forty-eight yards long was inoculated with surface soil, from old cultivated lupin land (8 cwt. per acre). The whole was harrowed and sown with lupins. The wet weather at the commencement of the experiment was unfavourable, but soon after the first leaves were formed the inoculation was shown to have been effective by the presence of nodules on the roots of the young plants. The plants growing on that part of the field which had not been inoculated had, as was expected, no nodules, with the exception of a few isolated plants. The difference in the appearance of the above-ground growth was soon very marked, the inoculated plants being quite normal in growth, the others light-red and yellowish. The amount of produce without, and with, inoculation, was 100 : 552.

Similar results were obtained with while clover, the heather being completely suppressed by the clover under the influence of inoculation.

In experiments with lupins growing in a heavy loam Schmitter obtained an increase of only 11 per cent. of corn and straw by inoculation. But, as Salfeld points out, such a soil is most unsuitable for lupins; moreover, the quantity of inoculating soil employed by Schmitter was very small. With regard to the effect of the physical nature of soil on the growth of lupins, it may be mentioned that in the pot experiments at Rothamsted(11) there was far more growth in loose, white sand, than in the lupin sandy soil itself from which the sand was inoculated. Billwiller (12) in discussing green manuring, gives two groups of plants suitable for different soils :—

1. For light to medium soils, white, yellow, and blue lupins, and serradella; and for calcareous soils, kidney-vetch, and lotus.

2. For medium to heavy soils, peas, scarlet, clover, sand vetch, Bokhara clover, red clover, alsike, and yellow clover; and for mixtures, horse-beans.

Light, sandy soils which are unsuitable for clover are chiefly to be utilised for green manuring—in Germany with lupins or serradella. It was, however, hoped that it might be possible to grow peas, and similar plants, successfully on such land, and some experiments were instituted in which garden and field peas were inoculated from pea soil. Lentils were also included, but there was no suitable soil available for their inoculation. The land was well manured with kainite and basic slag, and the two halves received respectively quicklime and marl (carbonate of lime). On the limed portion of the plants nearly all failed, and it was found that the roots were quite free from nodules, the microbes having apparently been destroyed by the lime. On the marled half of the field vegetation was luxuriant. The question of the effect of lime is one of considerable importance for some soils, and Dr. Tacke, of Bremen, accordingly made a number of pot experiments with the view of solving it It is not necessary to give

---

11. Lawes and Gilbert, Journal R.A.S.E., 1891. 3 Vol. 11., p. 683.
12. Inaug. Diss. Bern, 1895.

the details of Tacke's experiments;[13] he found that in sandy soil an application of lime corresponding with 24 cwt. per acre did not destroy the bacteria, and the results obtained with peaty soils were similar. It is therefore, concluded that in the field experiments above described the injury which still remains unaccounted for, was, at any rate, not due to the lime. The subject is now being investigated jointly by Drs. Salfeld and Tacke, and no doubt some explanation will, before long, be forthcoming.

IMPORTANCE OF SOIL INOCULATION IN AGRICULTURE.

It may be remarked, in the first place, that the results of Salfeld's and other experiments show that there exists soils which are so poor in nodule bacteria (Bacillus radicicola) as to require inoculation before certain leguminous crops can be suceessfully grown on them in absence of available nitrogen in the soil.

The most striking results were obtained with the poorest soils, newly cultivated peaty land giving luxuriant crops when suitably inoculated, after being limed or marled, and sufficiently manured with potash and basic slag; whilst without inoculation the same crop completely failed. The plants successfully grown were red, white, and alsike clovers, lotus corniculatus, serradella, horse beans, field and garden peas, etc. The same holds with sandy soils, which when inoculated gave good crops of lupins, serradella and clover. No experiments seem to have been made as yet with new loamy soil, but there can be no doubt that such land could be successfully brought under cultivation by similar treatment. On old cultivated land inoculation has not the same importance, but experiments alone will show whether it is beneficial or not.

Whether the bacteria of the different root nodules are different species, or modifications of one species, it is clear that judgment must be exercised in selecting soils for particular crops; and in some cases it may be desirable to experiment with different soils. But when a field is once suitably inoculated the soil of the field is available for any number of other fields which may require inoculation for the same crop. The quantity of soil to be applied will depend on the number of bacteria present in the soil, and also on the physical nature of the soil; the finer the soil, the better it can be distributed, and a small quantity of a readily pulverised soil will, of course, go further than a large quantity of soil which forms hard lumps. The amount of soil necessary may thus vary from about half a ton to a ton and a half per acre. Thorough incorporation with the land is most important to ensure proper infection of the young plants.

When a leguminous crop fails, the first thing to do is to examine the roots to see whether nodules are present; if absent, inoculation experiments should be made the following year. But there may, of course, be other reasons for the failure, such as acidity of the soil.

---

13. Mittheilungen d. Ver. z. Ford. d. Moorkultur, 1895. Bd. 13. No. 22.

The presence of plenty of lime is essential, and there must also be a sufficient supply of potash and phosphoric acid.

Results obtained by different investigators respecting the effect of the symbiosis on the character of the plant, especially as regards the production of roots, stems and leaves on the one hand, and of flower and seed on the other, are somewhat conflicting. Both Hellriegel and Nobbe found seed production to be retarded, whilst the yield of straw was increased. Nobbe, therefore considers the action of the bacteria more favourable to the production of fodder, and for green manuring, than for the production of seed. Salfeld thinks that the nature of the soil, and of the season, have a good deal to do with this. Peas grown in peaty soil often ripen very late, and the yield of corn was not always satisfactory as compared with the enormous production of stem and leaf, but this is ascribed mainly to the unfavourable weather and other conditions. In the case of lupins, very good seed was obtained on unmanured soil, whilst when heavily manured with potash and phosphates, the plants did not ripen at all. It is, therefore, proposed that in growing lupins, or clover for seed, potash and phosphates should be applied sparingly, if at all. In von Feilitzen's experiments with peas, referred to at p. 180, it will be remembered that the gain due to inoculation was chiefly in the production of corn, and that the quality of the corn was also improved by inoculation. However, it may be concluded that on the whole it is for fodder, and for green manuring, that soil inoculation will be chiefly employed.

The practice of green manuring, which has extended a good deal in Germany, will no doubt receive an impetus from the success which the numerous inoculation experiments have met with. Although it would seem especially adapted for improving poor soils, its adoption in ordinary farming will be watched with much interest. In connection with this part of the subject we cannot perhaps, do better than refer to the results of G. Dehlinger, of Weilerhof. Dr. Dehlinger, soon after taking possession of a farm near Darmstadt, decided to sell nearly all the cattle, of which a considerable number had been kept, keeping only sufficient to supply his own wants, and to adopt green manuring, supplemented with artificial manures, in the place of stable manure. Several years' experience convinced him that the system is more economical than any other, the cost of nitrogen in pea and vetch manuring being estimated at rather less than a penny per pound, as against about seven-pence in nitrate of soda, and tenpence in stable manure. Dr. Dehlinger also considers the system more unrestrained than when cattle are kept. Finally, he states that good crops were obtained after green manuring, and that the system is, on the whole very remunerative. It should be mentioned that two-thirds of his land is a heavy loam, and the rest a sandy loam. ([14]).

With regard to the more frequent growth of such plants as clover and peas, which are liable to sickness, it seems best for the present to keep to the old rules. We, are, as Dr. Salfeld says, still uncertain what the failure of these crops is due to, though Liebscher considers

---

14. G. Dehlinger, Viehlose grundungwirtschaft auf schwerem Boden. Berlin, 1892. Also Fream, "Farming without live stock," Journ. R. A. S. E., 1891, [3], Vol. II., p. 870.

that his observations indicate that it is caused by a nematode. Leibscher found that peas when grown ten times in thirteen years (with beans three times), on the same land were very stunted. By July the plants which had no nitrogenous manure were all dead, whilst those which were manured with nitrogen though still growing were unhealthy. The plants were found to have no, or very few nodules, on their roots, whilst similar plants in a rotation had many nodules, except where nitrogenous manure had been applied, in which case they were less abundant. An attempt to cure pea-sickness by inoculation from a good pea soil had no effect, and it was found that the roots of the unhealthy plants were covered with nematodes. Leibscher then grew about 100 varieties of plants of a pea-sick field, and obtained the following remarkable result. All the peas, and some varieties of vetch, had swarms of nematodes. Other varieties of the vetch, chick-peas (Kicher), Lathyrus Cicera and Cicer arietinum had fewer nematodes. The three kinds of lupins had very few, whilst Phaseolus, and all the various clovers which were growing in the field, had none at all. The gramineous and root crops were also free from nematodes.

The question arises, whether it is not possible that the attack by the nematodes on the plants named was the result, rather than the cause, of the sickness, The fact that peas and vetches were simultaneously attacked by the nematodes reminds one that both these plants grow in symbiosis with the same modification of the nodule bacterium, whilst clover, for instance, which was not attacked in this experiment, requires another modification and lupins which were very slightly attacked, again another modification. This seems to point to the total failure of one particular microbe (or modification, as the case may be) as the cause of failure of the corresponding plants; and the presence of nematodes on the roots of the peas and vetches might merely be due to decaying vegetable matter, as being to them a more suitable kind of food than the healthy roots of other plants. The fact that in Liebscher's first experiments the manured portion of the field suffered less than the unmanured would then indicate that the nitrogen supplied enabled the plants to at any rate keep alive without the symbiosis, and thus, to some extent, resist the attacks of the nematodes. We have a somewhat similar case in the clover experiments at Rothamsted. In a rich garden soil, thirty-seven cuttings of clover were obtained in twenty years (being resown only four times), whilst on arable land close by, it will not grow even once every four years in a rotation. Leibscher's view, that the peasickness was caused by nematodes, involves the assumption that clover has a special nematode, since it was not attacked in the least on the pea-sick land. The theory of the failure being due to the absence of the pea (or vetch) micro-organism is consistent with the fact that clover did not fail; since clover requires, and no doubt had, its own particular modifications. Against this we have the fact that inoculation with pea soil failed to cure pea-sickness; and this might be due to accident. The results are full of interest, and the question deserves thorough investigation.

Although it has been shown that adequate inoculation of the soil is essential, it has been as clearly illustrated that a greatly increased growth of leguminous plants cannot be attained without a liberal supply

within the soil, especially of lime, potash and phosphoric acid, and also of other ash constituents. ([15]).

In concluding, attention may be called to the paper relating to the recent patent taken out by Professor Nobbe and Dr. Hiltner for "Nitragin," ([16]) the object of which is to provide single leguminous seeds with the appropriate nodule organisms, instead of inoculating the land by means of cartloads of soil The question put by Sir J. B. Lawes, ([17]) more than a year ago. "Will the day come when seeds are sent out furnished with the appropriate organisms to supply the deficiency in our fields?" is thus already answered.

TAMARINDS.

The method of preparing tamarinds for the British market is the subject of a note in a Madras contemporary, from which it appears that the process is a very tedious one, requiring great care in packing. The fruit is first of all allowed to ripen on the tree, the shell being perfectly dry and coming away from the fruity part without any adherence. In preserving, the longest and most developed pods are chosen and shelled, the stalk, fibres, and seeds being allowed to remain intact. A syrup of crystallised sugar and water is then made over a slow fire, into which the tamarinds are carefully put piece by piece, and allowed to simmer until the pulp of the fruit has absorbed the syrup, care being taken not to allow the pulp to separate from the fibre. The vessel it then removed from the fire, and on cooling, the tamarinds are packed in earthenware pots glazed on the inside only. At the bottom of the pot a layer of white sugar is placed, on the top of which a layer of tamarinds is put, the gaps being filled by bending the fruit; over this is poured more syrup and another layer of sugar, and so on, layer after layer, until the jar is full. Circular paper saturated with brandy is placed on the top, the pots securely corked and stored away until the preserve becomes mellow, when they are ready for export. For this purpose jars with names or initials burnt or blown in are not used, as the contents may be removed before being passed through the Customs. (*Chemist and Druggist*).

---

15. See also concluding paragraph of Lawes and Gilbert's paper, already referred to (Journal R. A. S. E., 1892, [3] Vol. 11.. p. 701).

16. Deutsche landw. Zeitung, 1896, 40, No. 34.

17. Agricultural Student's Gazette, April, 1895. New series, vol. 7, 72.

FERNS: SYNOPTICAL LIST—LIII.

Synoptical List, with descriptions, of the Ferns and Fern-Allies of Jamaica. By G. S. Jenman, *Superintendent Botanical Garden Demerara.*

Sub-Order II. Marattiaceæ.

Sporangia destitute of a ring or crown, biserial, free, or fused into concrete linear, oblong, boat-shaped or circular masses (synangia), superficial or immersed in moulds, or with an inferior fimbriated involucral membrane, and opening by slits or small round pores; vernation circinnate; stipites enlarged and articulated at the base which is enclosed by a pair of projecting stipuliform gills; fronds varying from simple to decompound; veins free or united.

There are four well marked genera in this sub-order. In one, *Angiopteris,* the sporangia are quite free, but in the others they are combined into concrete synangia. Two, *Angiopteris* and *Kaulfussia,* are exclusively Eastern and Australian; one, *Danæa,* is exclusively Western; and the other, *Marattia,* is widely spread in the tropical regions of both worlds, extending south to New Caledonia and New Zealand. The individual sporangia are more or less oblong or oval in shape, but variable as the blocks into which they are fused. All the species occupy wet forests, are of a dark dull colour and have fleshy root-stocks bearing large scars, the articulations of past stipites, with thickish cord-like roots.

Synangia sessile or stipitate, oval or roundish before dehiscence, afterwards boat-shaped, sporangia opening by short slits. 1. Marattia.

Synangia linear, reaching from midrib to margin, sporangia opening by pores. 2. Danæa.

Genus I. Marattia, Swartz.

Synangia dorsal on the veins, small elliptical or roundish, sessile or pedicilate, bivalved, opening medially across the top at maturity into a boat-shaped form, the apertures in the 2–serial sporangia transverse to the line of dehiscence, and about six to a side; frond large, decompound, petioles without nodes, but articulated at the auricled base; veins free.

The members of this genus occupy damp forests and are usually gregarious. The swollen caudicular joints, common to all the species which remain for a time on the rootstock after the fronds have perished, produce a meal, which is used as food by some of the tribes of the Pacific islands, and is frequently to be seen on the rootstocks of *M. alata.*

Synangia sessile.
Fronds tripinnate.

1. M. alata.

1. *M. alata,* Smith.—Rootstock large and cone-like, marked with the scars of the joint like bases of past stipites; stipites 3–5 ft. l. 2 in., thick at the articulated base, cylindrical, early clothed with small, very deciduous, scales; fronds nearly deltoid, 3–5 ft. l., and nearly as w., tripinnate, chartaceo-herbaceous, dark green, paler beneath with a few deciduous scales: pinnæ spreading, opposite or sub-opposite, the lowest pair largest or hardly so, 2–3 ft. l., 1–1¼ ft. w. petioled and with a fleshy swelling at the base; abruptly acuminate at the apex; pin-

nulæ numerous, contiguous, oblong-lanceolate, acuminate, the point sharply serrate, slightly stipitate; tertiary segments ovate-oblong, cuneate at the sessile base, bluntish, 4–8 li. l., 2–3 li. w., serrated; costæ interruptedly winged in the outer part, costulæ so throughout; veins simple or forked; synangia one to each vein, a short way within the margin, the valves at length spreading.—*M. lævis*, J. Sm. *Dicostegia*, Presl.

Very abundant, gregarious in forests at 5,000–6,000 ft. alt., often covering extensive areas. When the petiole drops away, it leaves a a short joint at the base with the gills adhering to it. This is viviparous in the axils of the large auricles or gills, two buds appearing above and two below on the rounded back. One only however is usually developed, and this from either of the basal axils. The joints lie about plentifully, and when the plantlets are strong enough they root into the ground and proceed to maturity. Reproduction seems to be carried on much more largely in this way than from spores. The whole framework of the fronds is fleshy, and in drying becomes shrivelled and flat.

Genus II. Danæa, Smith.

Synangia linear or oblong, more or less immersed, running from the midrib to the margins on the free veins, very close and covering, except the costæ, the whole under surface, sessile, and broadly attached by the base, each one composed of a double row of numerous sporangia fused and blocked together, opening eventually by small apical pores; fronds simple or pinnate, dimorphous, the fertile somewhat reduced; stipites with or without distant nodes, and articulated at the auricled base.

This is entirely an equatorial American genus, and the largest of the sub-order. There is no great diversity of form in the genus, and the members differ chiefly in size and substance, number of pinnæ, number of nodes to the stems, and direction of growth of the rootstock. The sporangia are biserial, fused together into concrete linear synangia, which are immersed in a gum, or, when dry, gray-parchment-like substance, which surrounds them like a mould and forms thin partitions between their sides. The sporangia are multitudinous. Moderate sized fronds of *M. nodosa* contain from 300,000–400,000 each.

Fronds pinnate.
Stipites with 1–4 nodes.
Pinnæ under 1 in. broad.
1. D. alata.
2. D. stenophylla.
Pinnæ over 1 in. broad.
3. D. elliptica.
Stipites devoid of nodes.
4. D. nodosa.

1. *D. alata*, Smith.—Stipites fleshy cæspitose, erect, 6–9 in. l., scaly throughout; nodes 1–2; fronds oblong pinnate, usually rather narrower at the bottom and top, no terminal segment; beneath scaly, chiefly on the ribs, both sides rather pale green; rachis fleshy, scaly, narrowly winged interruptedly, with a small bud at the apex; pinnæ 8–12 or 14 to a side spreading, shortly stipitate, rounded at the base, or the lower ones sometimes more cuneate, the apex acute, or cuspidate

often, 2–3 in. l., $\frac{2}{3}$rds. in. w.; margins finely serrate in the outer part; plain within; veins very close, spreading at nearly right angles, simple or forked from the base; fertile fronds smaller, pinnæ $1\frac{1}{4}$–$1\frac{1}{2}$ in. l. $\frac{1}{4}$ in. w.; stipites longer, stouter, dark coloured, without joints, more scaly.

Frequently in very moist forests in the eastern parishes at 2,000–4,000 ft. alt., marked by its interruptedly winged rachis, and the absence of a terminal pinna. Sometimes a pinna appears to be terminal, but it is always at the side of the terminal bud. The name seems to be founded on Plumier t. 109, which is true *D. stenophylla*, Kz. Both names are so characteristically applicable to the respective species that it seems a pity to disturb them now.

CONTRIBUTONS AND ADDITIONS TO THE DEPARTMENT.

LIBRARY.

Botanical Magazine. August. [Purchased.]
British Trade Journal. August. [Editor.]
Chemist & Druggist. July 30. Aug. 6. [Editor.]
Garden. July 16, 23 & 30. Aug. 6. [Purchased.]
Journal of Botany. Aug. [Purchased.]
Journal, R Horticultural Society. July.
Nature. July 14, 21, 28. Aug. 4. [Purchased.]
Pharmaceutical Journal. July 30. Aug. 6.
Produce World. Aug. [Editor.]
Sugar. July. [Editor.]
Sugar Cane. Aug. [Editor.]
W. Indian & Com. Advertiser. Aug. [Editor.]
Sucrerie Indigène et Coloniale. July. Aug. 2 & 9. [Editor.]
Notizblatt, Berlin Gardens. July. [Director.]
Tropenpflanzer. Aug. [Editor.]
Bulletin de L'Herbier Boissier. July. Aug. [Conservateur.]
Report of Govt. Gardens, Mysore. 1896-97. [Curator.]
Circulars, R. Bot. Gardens, Ceylon. May 2. June 11. [Director.]
Times of Ceylon. June 30. July 7, 14, 21. [Editor.]
Tropical Agriculturist. July. [Editor.]
Reports Bot. Gardens. Hong Kong. 1897. [Director.]
Report Agri. Stations, Java. Apr. 24. [Director.]
Report Bot. Gardens, N. S. Wales. 1897. [Director.]
Sugar Journal, Queensland. June. [Editor.]
Queensland Agr. Journal. July. [Secy. Agr.]
Cape of G. Hope. Agr. Journal. June. July 7. [Agr. Dept.]
Central African Times. June 10. [Editor.]
Mauritius Revue Agricole. June. [Editor.]
Report of results obtained on Exp. Fields. Dodds Ref. Barbados. 1897. By J. R. Bovell & Prof d' Albuquerque. [Authors.]
Journal Jamaica Agricultural Society. August. [Editor.]
Bulletin R. Bot. Gardens Trinidad. July. [Editor.]
Proceedings Agr. Society, Trinidad. July. 12. [Secy.]
Publications of the following Agr. Experiment Stations, U. S. A. [Directors.]

Alabama	Illinois
Florida	Michigan
Idaho	Maine
	Virginia

Montreal Pharmaceutical Journal. August. [Editor.]
Reports on Agriculture Nova Scotia. 1898. [Editor.]

Agr. College Reports, Ontario. August. [Secretary.]
Experimental Farm Reports & Bulletins, Ottawa. 1897. [Botanist.]
Year book U. S. Dept. Agr. 1896. [Consul L. A. Dent.]
Hawaiian Planter's Monthly. July. [Editor.]

HERBARIUM.

From Mr. E. J. Campbell, Superintendent Botanic Gardens British Honduras.

Yellow or Broadleaf Logwood		(Wood Specimens & Leaves).
Catzim	"	(Wood Specimens).
Charack	"	(Wood Specimens).
Nicaragua	"	(Wood Specimens & Leaves).

PLANTS.

From Royal Gardens, Kew.

Andropogon Nardus
A. Schœnanthus
Dracaena sp. (O. Calabar)
Hedychium Horsfieldii
Malpighia coccigera
Mysore Cardamoms
Pandanus pacificus
Papaya Changona
Tacca viridis
Tephrosia Vogelii
Urostigma Vogelii
Adenium obesum
Agave albicans x mitis
A. attenuata
A. geminiflora
A. kewensis
A. marmorata
A. spicata
Aloe gasterioides
A. sp. (Somali land)
A. sp. (Hallack)
A. saponaria var. maculata
A. lineata
A. variegata
Beschorneria yuccoides
Crinum careyanum
C. sp (Accra)
Garcinia ternophylla
Honckenya ficifolia
Musa " albo-indica"
M. Livingstonei
M. Manni
M. Martabanica
M. Martini
M. rosea
M. Sumatrana
M. superba
M. textilis
M. vittata
Echidnopsis dammaniana
Euphorbia bupleurifolia
E. Caput-Medusae
E. lactea
E. meloformis
Phyllocacti (6)
Pitcairnia coerulea
P. ferruginea
Puya chilensis
Sansevieria cylindrica
S. Ehrenbergii

SEEDS.

From Botanic Gardens, Singapore.
Mezoneurum sumatranum
Albizzia moluccana
From Botanic Gardens, British Guiana.
Dypsis madagascariensis
From Royal Gardens, Kew.
Tacca pinnatifida
Villebrunea integrifolia
Uapaca Kirkiana
Toxicodendron capense
From H. Dixson, Esq., Sydney, Australia.
Cycas Normanbyana
*From Curator, Botanic Gardens, Durban, Natal.**
*From Director, Royal Botanic Gardens, Peradeniya, Ceylon.**

* Burnt on receipt, as there is a Government prohibition against receiving seeds or plants from these colonies for fear of introducing the Coffee Leaf Disease, *Hemileia vastatrix.*

[Issued 1st October, 1898.]

New Series.] SEPTEMBER, 1898. Vol. V. Part 9.

BULLETIN

OF THE

BOTANICAL DEPARTMENT, JAMAICA.

EDITED BY

WILLIAM FAWCETT, B.Sc., F.L.S.

Director of Public Gardens and Plantations.

CONTENTS:

PRICE—Threepence.

A Copy will be supplied free to any Resident in Jamaica, who will send Name and Address to the Director of Public Gardens and Plantations, Kingston P.O.

KINGSTON, JAMAICA:
GOVERNMENT PRINTING OFFICE, 79 DUKE STREET.

1898.

JAMAICA.

BULLETIN

OF THE

BOTANICAL DEPARTMENT.

New Series.] SEPTEMBER, 1898. Vol. V. Part 9.

AGRICULTURE OF THE SUGAR CANE.—III.

Extracts from "Sugar Cane, Vol. 1." by DR. WILLIAM STUBBS, Director of the Louisiana Sugar Experiment Station.

Edited by FRANCIS WATTS, Government Chemist Jamaica.

MANURIAL REQUIREMENTS OF SUGAR CANE.

(*continued*).

PHOSPHORIC ACID PLAT.

Similar questions as to the requirements of this soil for phosphoric acid, to those given under nitrogen, have been propounded to this plat, viz.: First—Does this soil need phosphoric acid to grow cane? Second—If so, in what form can it best be prescribed? and Third—In what quantities per acre? The forms of phosphoric acid used were, "Dissolved Bone Black," "Acid Phosphate," "Ground Bones," "Thomas Slag," "Charleston Floats," and Natural Phosphates or Guanos They were used in such quantities as to furnish thirty-six and seventy-two pounds of phosphoric acid per acre. Larger quantities than seventy-two pounds per acre have proven by experiments to be unprofitable. These forms were used alone, and combined with excessive quantities of nitrogen and potash. The most available and adaptable forms to cane were used, viz.:—Sulphates of Ammonia and Potash. As in other plats at regular intervals, there were the usual number of unfertilised experiments, and experiments containing only Sulphates of Ammonia and Potash. Like the nitrogen experiments, these have already extended over eight years, and will be continued indefinitely. The results so far indicate positively the value of phosphoric acid in manures for sugar cane on these soils, but the demand for this ingredient is small in comparison to that for nitrogen, the smaller quantity given above (thirty-six pounds per acre), proving so far an ample quantity for maximum yields. Results further show that the soluble forms of phosphoric acid are preferred, followed in order by slag meal, and finely ground "floats," etc. Therefore, quantities of phosphoric acid, from thirty to forty pounds per acre, in a soluble form are to be recommended for sugar cane on our soils. Phosphoric Acid unlike nitrogen, can not be

drawn from the air by leguminous crops. It is true that the latter, by their deep tap roots, pump it up from the lower strata of the subsoils and by turning them under as green crops, the phosphoric acid is transferred from the subsoil to the surface soil, and is thus placed within the reach of the roots of the subsequent cane crop. If, however, both soil and subsoil be deficient in this ingredient, recourse must be had to some commercial fertiliser containing it, in order to grow maximum crops. A crop of cow peas can and does supply a soil with nitrogen drawn directly from the air, and in doing so makes a positive addition to the store of fertility in the soil. By its tap roots it may transfer phosphoric acid from subsoil to surface soil, but in doing so it has not increased the stock of plant food on hand, but simply transferred it to a more eligible position for assimilation by cane. Therefore phosphoric acid is equally needed by both plant and stubble cane. (1)

EXPLANATIONS OF FORMS OF PHOSPHORIC ACID.

Dissolved Bone Black.—Bones are subjected to destructive distillation in the process of "Charring," by which the larger part of their organic matter is driven off, and with it their nitrogen. A part of the carbon existing in bones as organic matter, is now left as charcoal, encrusting each grain of phosphate of lime. When thus prepared it is called "Bone Black," or "Bone Charcoal," which is extensively used in sugar refineries for decolourising and defecating syrups destined for white sugar. After constant use, the bone black becomes "spent," i.e., no longer exercises a decolourising influence upon syrups. It is then sold for fertilising purposes. Sometimes it is without further treatment, applied directly to the soil, but without immediate benefits, since the phosphates, being encased in charcoal, are protected from rapid de-

(1) The part played by phosphatic fertilisers in relation to sugar cane presents features which at present are involved in some obscurity. While for the most part it may be assumed that on the majority of soils canes are benefited by the application of small doses of phosphates, other experiments have shown that moderately large applications are not beneficial, and may even result in diminished yields. The experiments conducted at the Antigua Experiment Station tended to show that, under the conditions of soil and climate prevailing there, the application of phosphates, instead of increasing, actually diminished the yield, and this, whether the phosphate was applied in the form of super-phosphate, mineral phosphate or basic phosphate. Again, at the Barbados Experiment Station in the first series of experiments conducted, it was observed that while a small application of super-phosphate increased the yield of canes somewhat, larger applications resulted in smaller yields, and in later experiments during 1896 and 1897 similar results are arrived at. Experiments conducted in Demerara, give results tending in the same direction. It is significant that unexpected results of this kind should be reported from places so distant and widely separated as Demerara, Barbados and Antigua.

Although on the whole phosphatic manures may be desirable and beneficial, it is evident that considerable care should be exercised in their use. It is frequently suggested that the prejudicial action is due to a deficiency of carbonate of lime in the soil. It is true that the soil on which the Antigua experiments were conducted was very deficient in carbonate of lime, but it appears improbable that the injurious action of the phosphates can be wholly traced to this as a cause, seeing that not only super-phosphate, but also neutral and basic phosphates exercised similar influence. The Barbados soil contains more carbonate of lime than that of the Antigua Station, though in this case the quantity is but small. This question calls for careful investigation. It seems possible that the application of phosphates, even when in a neutral or basic form, may so affect the activity of various soil ferments as to lead to the results observed.—F. W.

composition. To overcome this slow action and render it immediately available, it is treated with sulphuric acid, and the resulting product is "Dissolved Bone Black," a most valuable and available form of phosphoric acid, containing usually about 16 per cent. to 18 per cent. soluble phosphoric acid.

Acid Phosphate.—Formerly Bone Black, Bone Ash, or Ground Bones were used for treatment with sulphuric acid, but the demand becoming greater than the supply, recourse was had to the newly discovered beds of mineral phosphates and to-day much the larger quantity of soluble phosphates are mannfactured from the mineral phosphates obtained in various parts of the world; South Carolina, Florida and Tennessee each furnishing large quantities annually. These mineral phosphates, after being cleaned from adhering dirt, sand, etc., are ground to a fine powder by the "roller" process, and sold on the market as "floats," or are treated with sulphuric acid and converted into soluble phosphates which are called "Acid Phosphates," "Superphosphates," or "Dissolved Bones." The amount of soluble phosphoric acid which they carry varies from 10 per cent. to 20 per cent., according to the purity of the phosphate from which they were made. If phosphoric acid is used to dissolve the bone black or mineral phosphates, the resulting product will be much higher in soluble phosphoric acid. In this way are made the so-called "Double Superphosphates" which are sometimes found on our markets, and which contain from 40 per cent. to 50 per cent. of soluble phosphoric acid.

In the treatment of either bones, bone black, or mineral phosphates, with sulphuric acid, if enough of the latter be used, all of the sulphuric acid will become soluble in water. The above substances are tricalcic phosphates, containing three molecules of lime to one of phosphoric acid, and are soluble only in acids. They are, therefore, slowly soluble in soil water, and are not a readily available form for plant food.

Treated with sulphuric acid, they lose two molecules of lime, which are appropriated by the acid, and recover in exchange two molecules of water, leaving one molecule of lime combined with one molecule of phosphoric acid and two molecules of water. The resulting products are now monocalcic phosphates, and are very soluble in water, and therefore readily available to plants.

Should a deficiency of sulphuric acid be used in the manufacture of soluble phosphates, a quantity of the tricalcic phosphates will be left unacted upon by the acid while another portion will be converted into monocalcic or soluble phosphate.

If this mixture be permitted to remain in bulk any length of time, a chemical reaction takes place, by which a dicalcic phosphate is formed, which is insoluble in water, but soluble in certain salts, notably the citrate of ammonia, and is called "reduced," or "reverted," phosphates. The change is as follows:—One part of insoluble phosphate, containing three molecules of lime, and one part of phosphoric acid, reacts upon another part of soluble phosphate containing one molecule of lime and one of phosphoric acid to form two parts of "reduced," or "reverted," phosphate, which contains two molecules of lime and one of phosphoric acid. These three forms of phosphoric acid are found in every "Acid Phosphate," or fertiliser, containing acid phosphate. They are usually denominated as "soluble," "reverted," and "insoluble," and to the Chemist are known as "water

soluble,'" "citrate soluble," and "acid soluble" phosphoric acids. In some States the soluble and reverted are classed together as "available" phosphoric acid, a term which has been adopted by the manufacturer rather than the agriculturist, since the question of availability in the soil is yet an undetermined one and varies greatly with the character of the soil. It is true that the soluble phosphoric acid, when applied to the soil, after a while reverts, from contact with basic principles in the soil, but before doing so it diffuses itself throughout the soil, and by this initial velocity becomes thoroughly incorporated with it, and when precipitated in the reverted form, each particle is so minute as to be readily available to the acid secreting roots of plants. The reverted phosphates being insoluble in water, lack this initial diffusion, and therefore remain in the exact position in which they were placed by the planter. The particles are more segregated and less diffused, and therefore less available.

In buying phosphates, therefore, due regard should be given to obtaining the highest possible content of soluble phosphoric acid.

Slag Meal is a by-product in the manufacture of steel or wrought iron by the "Thomas Gilchrist" process, from pig iron rich in phosphoric acid. The pig iron is melted in converters lined with lime and when thoroughly melted, the lime unites with the phosphoric acid present, and forms a slag which floats on the surface of the melted iron. This slag is removed, cooled and ground into a powder, and sold as "phosphoric slag," or "slag meal." Besides phosphate of lime, it usually contains goodly quantities of lime, and therefore cannot be mixed without injury with fertilisers containing either ammonia or soluble phosphates. It usually contains 15 to 20 per cent. of phosphoric acid, and upon some soils, with certain crops, is highly esteemed. It has not proven as valuable under sugar cane as the soluble forms. There is a promise of a large supply of this slag in the near future by the manufacturers who work iron by this process.

Natural Phosphates.

Besides the mineral phosphates already described, there are found on the smaller islands of the ocean, immense deposits of phosphates, which require little or no manipulation to prepare them for use. They are believed to be the residues from the deposits of fish-eating birds. In a rainless climate, like Peru, such deposits give us the celebrated Peruvian guano, rich in both ammonia and phosphates. In a rainy climate, such as prevails in the Caribbean Sea, the ammonia and other soluable matters have been washed out, leaving only the insoluble phosphates. In such a manner has originated the natural guanos, known as Grand Cayman, Redonda, Orchilla, Carib, etc , all coming from islands in the Caribbean Sea. These natural guanos should be used with great care, since they are simply phosphates, and not what their name imports "guanos."

In selecting phosphates for use, intelligent farmers, both in Europe and America, give preference to "super," or "acid phosphates" a fact evidenced by the ever-increasing demand for these goods.

Potash Plat.

On this plat, the Nitrogen and Phosphoric Acid are the constants and the form and quantity of potash the variable. Does this soil need potash to grow cane? If so, in what form, and in what quantity shall it be used? The nitrogen in this plat has been furnished in the form of Sulphate of Ammonia and the Phosphoric acid in Acid Phosphate. The potash has been supplied in Kainite, Muriate of Potash, Sulphate of Potash, Carbonate of Potash, and Nitrate of Potash. Such quantities of each were used as to furnish 25 to 50 pounds of pure potash per acre.

There were also present the usual Nitrogen and Phosphoric Acid. These experiments have extended over eight years, and are being continued.

So far, no results of any character, either in the increased sugar content or tonnage per acre have been visible from the use of any form of potash, upon the alluvial lands of the lower Mississippi. Several forms of potash, notably the carbonate, and ashes of cotton seed hulls, have rather decreased the yield of cane and injured the physical qualities of the soil, by causing it to "run together." That this soil should not require potash in fertilisers adapted to them is to be anticipated from its chemical analysis given elsewhere, which shows an abundance of potash. It is further corroborated by the magnificent growth of white clover, wild alfalfa, and melilotus officinalis, growing luxuriantly over almost every headland, and by the excellent crops of cabbages, red clover, alfalfa (Medicago sativa), and cow peas, cultivated more or less extensively throughout this section. All of these plants are known to require large quantities of potash for their best development Where are they grown better and more successfully than in the alluvial lands of South Louisiana?

In New England and the north of Germany, potassic manures are held in high esteem.(2) The application of potash manure has proven a panacea for "clover sickness" on the the soils of Scotland. On soils rich in humus, potassic manures are said to release nitrogen, and thus give excessive growth to plants grown thereon. This is a familiar occurrence to all farmers in the spots where log heaps have been burned. Such spots withstand drought well, since they are better supplied with moisture by capillarity.

Sources of Potassic Manures.

Formerly ashes and green sand marl (Glauconite) furnished all the potash for commerce and agriculture, but the opening of the Strassfurt and Leopoldshal mines of Saxony have furnished the world with every form of potash. The following are the products :—

First-Kainite. a crude product of the mines, containing 12 per cent. of potash, and is a mixture of chlorides and sulphates of potash, soda, and magnesia.

Second-Muriate of Potash, a manufactured article containing 50 per cent. of pure potash.

(2) The experiments conducted at the West Indian Experiment Stations lead to the conclusion that, under the conditions of the experiments, the use of potash as a fertiliser is beneficial to sugar canes in the West Indies.—F. W.

Third-Sulphate of Potash of varying purity, containing 24 per cent. to 50 per cent. of potash, is also a manufactured article.

From these forms the others, carbonate and nitrate, are manufactured.

How shall Fertilisers be applied?

A rational discussion of the properties of each one of the three ingredients of commercial fertilisers will enable us to intelligently appreciate the proper methods of applying them. Nitrogen, the ingredient most desired by cane plants, is the transitory one of commercial fertilisers. It is to-day a gas, forming a part of the atmosphere; tomorrow it is a solid in the plant. It is now an ingredient of soil water, and is either appropriated by plants, fixed by the soil or leached out into springs and rivers, to be finally " in the dark bosom of the ocean buried," there to be abstracted and appropriated by fish, which in time furnishes pabulum for man or manure for plants. The idea of rest or permanence is foreign to the chemistry of this element, as to the atmosphere of which it forms so large a part. Therefore, all nitrogenous manures should be used with care and caution, especially those which contain actual ammonia and soluble nitrates. Therefore, in using Nitrate of Soda, it should be applied as a top dressing only on the growing crop, and at short intervals in small quantities. Sulphate of ammonia is also liable to leaching, but may be lost by excessive use, or application, at an improper time. The organic nitrogenous fertilisers mentioned above must be gradually oxidized and converted into nitrates as explained elsewhere under " Nitrification," before they can become available as plant food. Soil conditions determine largely the rate at which this nitrification takes place, and excellent tilth with subsequent frequent and shallow cultivation favour the rapid decomposition of organic nitrogenous fertilisers. Messrs. Lawes and Gilbert have found that cotton seed meal formed, when applied to a soil not too dry, a slow but continuous supply of nitrates. The oil present perhaps cripples the nitric ferment, and prevents too rapid nitrifaction. As shown elsewhere, nearly all of its nitrogen is available in one season. Dried blood is a quickly acting manure, requiring only a slight covering in the soil for conversion into available plant food. It may even be used as a top dressing.

Tankage, so far as its content of blood goes, has similar properties. The bone and meat portions, particularly the former, are much slower of action. Fish scrap acts more slowly, and there is no evidence that all its nitrogen ever becomes available. However, in the South, if turned too deeply in a warm mellow soil with moderate humidity, the results are fairly satisfactory. It cannot be profitably be used either as a top dressing or when turned too deeply, since in both instances fermentation is prevented; nor will it yield good results in early spring upon cold, damp, soils, but in warm sunshine it may do excellent service upon both corn and cane.

It has been shown elsewhere that soluble phosphates, soon after their application to the soil, revert to insoluble forms. It was also shown that before reversion, its solubility rendered its distribution through the soil more thorough and uniform, thus securing advantages not obtained by other forms of phosphoric acid. In such soils the roots of crops grow regularly, continuously, and rapidly, and not spasmodically and inter-

mittently, as when they pass through spaces of soils free from phosphates. Again, these micro-organisms, regarded now as essential to soil fertility, and which specially favour fermentations, and which convert inert plant food into assimilable forms, can prosper only when phosphates everywhere abound. Besides superphosphates are exceedingly beneficial to young crops, in hastening them beyond the period when they are most susceptible to the attack of parasitical insects.

Potassic manures are so readily fixed by the double silicates in loams and clays that it is almost impossible to secure their proper dissemination through a soil. They are, therefore, as a rule, not to be recommended as a top dressing. Properly speaking, they should be applied some time before the crop is planted, so that by repeated ploughing and harrowing, they may become well mixed with the soil However, salts of potash have different diffusive powers in themselves, which are greatly modified by admixture with other manures. Hence, the refinement of fertilisation would require that in compounding commercial manures, that form of potash should be used which would be increased in diffusive power by the presence of the forms of nitrogen and phosphoric acid used.

AT WHAT TIME SHOULD FERTILISERS BE APPLIED?

From what has been said, it is evident that the separate application of each ingredient of commercial fertilisers at such a time and in such quantity as the characteristics of the individual soil and crop would suggest, would be the most scientific course of procedure.

Potassic manures could properly be applied several months before planting a crop. Super or acid phosphates a little before or at the time of planting, while nitrogen should be furnished only to meet the demands of the growing plants, and then only in such quantities as will supply immediate necessities. The above are the suggestions of science, but unfortunately, in our present stage of advancement, they cannot be rigidly followed. The larger part of the supply of our commercial fertilisers are manipulated goods containing two or more ingredients, and therefore separate applications cannot be followed.(3)

DEPTH AT WHICH FERTIIISERS SHOULD BE PLACED.

As already seen, potassic fertilisers should never be applied on the surface of growing crops, since fixation would occur there and the rootlets of plants never find it. It has been found that the more these fertilisers are diffused through the soil the better the results obtained. Depths of two to ten inches is the range of cane roots in an average clay soil. Therefore, an application at four to five inches, to be subse-

(3) It is quite within the power of planters to purchase the potassic, phosphatic and nitrogenous constituents of fertilisers separately and to apply them at such times as experience shows to be most suitable. Potash and phosphates may be applied during the period of preparing the land for plant canes, or, in the case of ratoons, soon after the plant canes have been cut. In this way they become well incorporated with the soil by the operations of tillage and weeding before great root development takes place. The nitrogenous fertilisers can be applied to the growing crop at a later period in small quantities, as top dressings at such times as the crop appears to demand an application of assimilated nitrogen, a condition which, in the case of the sugar cane, the experienced planter has little difficulty in recognizing.

quently mixed by the plough and cultivator, will probably be the best depth for all potassic manures. Super or acid phosphates require a small depth, but a very extended width, covering, if posible, the entire distance to be manured, They should be scattered at a depth of two or three inches over the area to be occupied by the roots of plants.

Nitrates and Salts of Ammonia are always best used as a top dressing at short intervals, in small quantities.

Dried Blood requires but little depth, provided moisture necessary for conversion into available plant food be present.

Cotton Seed Meal requires a little more depth than Dried Blood, while Tankage, Bones and Fish Scrap must be sunk to deeper depths to obtain fermentation necessary to their conversion into soluble plant food.

None of the above should be turned too low, especially in stiff soils, since air, moisture and heat are the factors needed in decomposition. Here as elsewhere in good agriculture, the judgment of the planter must decide, after a thorough acquaintance with his soil. Proper depths may vary from two inches in a stiff clay soil to six or eight inches in loose sands.(4)

CONCLUSIONS.

Shall our manipulated fertilisers, such as Tankage, Cotton Seed Meal or complete fertilisers, be applied at the time of planting, or later during growth? Shall they be applied broadcast or in drills? Shall they be applied in large, or small quantities? Positive replies to these questions suitable under all circumstances, cannot be given, and here again the farmer must use his judgment after stndying his environment. The following will aid him, however, in deciding, Under

PLANT CANE

a small quantity of readily available fertiliser directly under and near the cane is highly beneficial, since the double line of rootlets which are disposed in concentric rays around the stalk develop simultaneously with the bud and feed the young shoot. Experiments given elsewhere show the superiority of stalks thus manured over those unfertilised. Especially is this true when the seed is more or less unsound.

Again, the rootlets emerging from the base of the young plant simultaneously with the sucker, finding food at hand, aid greatly in develop ing a healthy sucker, and thus give the entire plant a vigorous send off in youth. This is especially desirable in Louisiana, where we harvest cane after a growth of a few months, and doubly desirable for that cane destined for the mill in early fall.

In Louisiana, cane is planted from September to April. The planter should decide from the character of his soil, whether the loss from leaching to his nitrogen, during the winter would be greater than the benefits to his crop, and act accordingly. The simple question is thus presented. Nitrification goes on throughout our entire winters, and if some crop is not present to consume the nitrates formed, they will leach

(4) The practice of plaçing fertilisers in small holes near to the cane plants, common in some places, is to be condemned, for when such a method is followed only the more soluble and diffusible constituents become available for the crop to which they are applied.

(more or less, depending upon the character of soil) into the drainage waters, and be lost. Sugar cane grows very little during the winter, and is, therefore, incapable of utilising much nitrate. Will, therefore, the benefits accruing to the cane be more than counterbalanced by the losses from nitrification and subsequent leaching?

Again, it may be said that in fall or winter planting of cane, the good judgment of the planter must be used in determining whether fertilisers shall be simultaneously applied. In spring planting, no doubts exist as to the advisability of placing a small quantity of readily available fertiliser directly under and near the cane, provided two applications can be made —the other in the month of May. If, however, only one application is feasible, let this be made at the time of planting in the spring. It is too necessary to give a vigorous start to a young plant, to withhold manures until you have a stand. ([5]) Usually the more perfect the incorporation of a manure in a soil, the better the results to be expected, and therefore, in countries where short seasons and flat culture prevail, manures are usually broadcasted and thoroughly mixed with the soil before planting Such a procedure here would be reckless in the extreme. The character of our lands and the methods of preparation and cultivation, forbid broadcast manuring. The manure must be deposited in an open drill. Into this drill it should be broadcasted, and machines which deposit fertilisers in continuous rolls should be amended by a shaker placed just below each sprout, so as to scatter the fertiliser within the open furrow. After scattering, the fertilizer should be well mixed with the soil by a fluke or double mould broad plough.

In the spring, after the cane is closely off-barred, the fertiliser, if not applied at planting, should be scattered on both sides of the plant, from the centre of row to the off-barred furrow. In reversing the furrow, the manure is covered, and subsequent cultivation will mix the latter with the soil If the cane has received the first application at planting, the second one should be given in May on both sides of the row, off-barring lightly with a one-horse plough at a distance on each side of at least one foot from the centre of the row of plants.

STUBBLE CANE

should not be fertilised very long before each sprout has sent out its own rootlets, since prior to this no good could be accomplished, and there would be a waste of manure. The quantity to be used under both plant and stubble cane, has already been discussed.

Upon a pea fallow, plant cane requires but little nitrogen and goodly quantities of phosphoric acid. They should be used in the proportion of at least one of nitrogen to two of phosphoric acid. An acid phosphate, containing 14 per cent. of phosphoric acid, mixed with an equal quantity of cotton seed meal, will give a mixture containing these proportions. On "succession" cane, nitrogen should be largely increased for reasons given elsewhere, and may sometimes reach with propriety two of nitrogen to one of phosphoric acid. This is very nearly the

(5) In most parts of the West Indies an effort is made to apply either a green dressing or an application of pen manure, (farm yard manure,) to the fields during the preparation for planting; where this is done a good supply of available plant food will exist in the soil ready for the nourishment of the young rootlets of the cane.

proportion that these ingredients occupy in good cotton seed meal, hence the excellent results obtained by some planters on black land, and with "succession" cane, by the use of this fertiliser alone. Ordinarily, on sandy or medium lands, a mixture of two parts of cotton seed meal and one part of acid phosphate will be found most desirable. This same mixture will also best serve first year stubble coming from plant cane which succeeds a pea fallow.

In fertilising cane, due regard should be had for the character of the soil and its ability to furnish the much needed element, nitrogen, and the distance of a crop from a pea fallow.

Knowing these factors the proportion of nitrogen to phosphoric acid must be varied accordingly. extending from one of nitrogen to two of phosphoric acid, to two of nitrogen to one of phosphoric acid.

Cotton Seed Meal has been used in the above calculations, simply because it is a most excellent source of nitrogen, and a home product. (6) Tankage or any other form may be used for the cotton seed meal, by taking enough of the former to replace the nitrogen contained in the latter. Potash is not believed to be necessary in manures for cane on Louisiana soils.

A considerable space has been devoted to a discussion of fertilisers, because there is no element of farm expense so cheap as the rightly compounded manure, especially under cane.

Under this crop, the right manure not only shows itself in the increased tonnage of cane and yield of sugar, but in the increased vitality of the succeeding stubbles.

(*To be continued.*)

BANANA MEAL.

The following information on the difficulty of finding a market for Banana Meal is supplied by a local correspondent:—

Apparently the only chance for success is the possibility of reducing the cost of production to such a figure that the banana meal may compete with flour or corn meal. This could only happen when the bananas were practically waste, e.g. small bunches in the season for bananas, and even large bunches when out of season

"With reference to Banana Meal, there is really no market nor outlet for it, and I have been working the thing for all it is worth, and have spent about £300 over it, trying to get a satisfactory market, but all to no purpose.

"Quotations have been made by Messrs. John Haddon & Co., Belvedere House, Salisbury Square, London E C, as being worth about £27 a ton of 2,240lbs. ex warehouse the docks, London, I have offered to supply at those rates.

"I have sent tons of the meal to various countries all to no purpose — as the market seems to want it to compete with wheat or rice.

(6) The proper use of green dressing and of pen manure, will do much to maintain an adequate supply of nitrogen.

Oil crops, such as Castor or Ground nut (Pindar) might be profitably grown in most of the West Indian Islands, then a supply of the residual meal would be available to planters for fertilising purposes.

"All I can manage to sell is a barrel now and then. I sell at 3d. per lb. landed in Kingston.

"The dried banana, as a fig, is a failure, as the vinous fermentation sets in so quickly that by the time the fruit has been in England 2 or 3 months, it is too unsightly to look at the second time, or as my London Agents wrote to say. 'Its too suggestive.'

"I am sorry I cannot give you a brighter account.

"Mr. Geast, if he could have got the meal in free to the States, would have taken all the island could have produced at £30 per ton ex warehouse New York. He wanted it for a new kind of beer."

JAMAICA SATIN WOOD.

In the Bulletin for April, 1897, a description of the tree and wood of Satin Wood was given, and later in October, a Market Report on Cabinet Woods gave prices from different localities.

A query was addressed to Messrs. Churchill and Sim as to the reason for the difference in quoting price, and the following information was received :—

"In reply to your enquiry about quotations for Satin Wood, we beg to say the reason why Jamaica wood is quoted at per ton weight, is that the logs shipped from that Island are generally of small sizes —say from 4 to 6 or 8 inches at the utmost, and they are often shipped in the round; whereas from Porto Rico and St Domingo the logs are always hewn square, and range from 10 inches and upwards. Wide wood of these sizes sell better by measure but the small wood gives the best results when sold by weight. For quality, Porto Rico Satin Wood is the best, then St. Domingo and then Jamaica. Squared logs of Sat.n Wood usually yield from 280 to 300 superficial ft. of 1 inch thick. London Brokers Sale Measure per ton of 2,240lbs. weight, the measure by which this wood is sold here is a measure with allowances according to the custom of the trade, and is about 20 per cent. less than the actual or extreme measure in the log, in Liverpool the Sale Measure is about 10 per cent. more in Buyers' favour."

PLANTS IN THE GARDENS.*

Artabotrys odoratissimus, R.Br.—This is a large woody climber with strongly scented yellow flowers, the odour of which is closely allied to that of the Ilang-Ilang (*Cananga odorata*).

Climbers have many adaptations for attaching themselves to other plants, and so rising to the light above. The means by which this plant does so is a flower stalk, which bends round and becomes hard and woody, forming a strong hook by which it clings fast and climbs upwards.

It is a native of India, Ceylon, Java and China. *(Anonaceæ.)*

* These can all be obtained on application to the Director.

ARTOCARPUS LAKOOCHA, Roxb.—A large tree, nearly allied to the Bread Fruit and Jack Fruit. It is not so important for its small fruit which is eaten in curries, as for its wood, which is hard and yellow, taking a good polish. A fibre is prepared from the bark, used for cordage.

It is a native of India and Ceylon. (*Urticaceæ.*)

ARTOCARPUS NOBILIS, Thw.—Another species of the same genus, also a large tree. The seeds are roasted and eaten. The wood is used for furniture and canoes, as in A. Lakoocha.

It is a native of Ceylon. (*Urticaceæ.*)

BAUHINIA VARIEGATA, Linn.—A small shrubby tree with deciduous leaves and very ornamental large flowers, which vary greatly in colour from white variegated with yellowish green to rose variegated with crimson, cream-colour and purple. *Bauhinia candida* is a white variety.

It is native of India and China, but is common in Jamaica.

The bark is described by Watt as "alterative, tonic, and astringent, useful in scrofula, skin diseases and ulcers." It is also used in dyeing and tanning. "The root in decoction is given in dyspepsia and flatulency; the flowers with sugar as a gentle laxative." (*Leguminosæ.*)

BAUHINIA MEGALANDRA, Griseb., is another tree of the same genus, a native of some of the W. Indian Islands. It is one of the trees known as Mountain Ebony, but the wood of the Bauhinias, though tough and hard, is too small to be of much value.

BAUHINIA VAHLII, W. & A. is an enormous climber, doing in this way damage to forest trees in India. but it is very useful, as the strong fibre of the bark is made into ropes.

CARAPA GUIANENSIS, Aubl. The Carapa tree of Guiana grows to a height of 60 to 80 feet. The timber is light, having a specific gravity of 0.603, but it takes a good polish, and is used for making furniture; also employed for shingles, and for masts and spars of ships. The bark is astringent, is used for tanning, and medicinally as a febrifuge. The large, round fruit contains several oily seeds, from which is obtained a lamp oil. It also grows in Brazil and some of the West Indian Islands.—(*Meliaceæ.*)

COUROUPITA GUIANENSIS, Aubl., the Cannon Ball Tree, so-called from the size and shape of the fruit. The pulp is of a pleasant flavour, and the hard, wooden shells are used as drinking vessels, &c. The flowers are large, whitish or rose coloured, forming clusters on the trunk and branches, The stamens are remarkable; they cover a ring round the centre of the flower; this ring is expanded on one side, the expansion is as broad as the ring, flat, and gradually turns over the centre, forming there a semi-globular hood, concealing the ovary, and covered on its inner surface also with stamens, which alone are fertile.—*Lecythideæ; Myrtaceæ.*

DIOSPYROS DISCOLOR, Willd,, the Mabola tree, is one of the woods affording Ebony. It is a native of the Phillipines The fruit, called Mabola, is edible.—(*Ebenaceæ.*)

PTEROCARPUS DRACO, Linn. This is a native Dragons Blood Tree. When an incision is made in the bark, drops of red sap ooze out, which

flow slowly down the bark and gradually harden. This was formerly exported from Cartagena to Spain as "Sangre de Dragon." It does not however agree in composition or properties with the dragon's blood from the East Indies. It should be classed as a kino, and if found in sufficient quantity, might be used medicinally. (See Bulletin, August, 1895).

The tree has compound leaves, somewhat like the common cedar, yellow pea-like flowers, half an inch long, and a flat, rounded pod, containing one seed.— (*Leguminosæ*).

SAN JOSE SCALE INSECT.

A plant-pest known under the above name has recently attracted a good deal of attention in the United States and Canada, as well as in England and on the Continent. A special Bulletin has been issued on the subject by the United States Department of Agriculture.* The original home of this scale (*Aspidiotus perniciosus*) is at present unknown. It was observed in an epidemic form in the San Jose Valley in California, about 1870. Since then it has rapidly spread in every direction in the United States. The seriousness of its attacks may be gathered from the following extract:—

"There is perhaps, no insect capable of causing greater damage to fruit interests in the United States, or perhaps the world, than the San Jose, or pernicious scale. It is not striking in appearance, and might often remain unrecognized, or at least misunderstood, and yet so steadily and relentlessly does it spread over practically all deciduous fruit trees—trunk, limbs, foliage, and fruit—that it is only a question of two or three years before the death of the plant attacked is brought about, and the possibility of injury, which from experience with other scale enemies of deciduous plants, might be easily ignored or thought insignificant, is soon startlingly demonstrated. Its importance from an economic standpoint, is vastly increased by the ease with which it is distributed over wide districts through the agency of nursery stock and the marketing of fruit, and the extreme difficulty of exterminating it where once introduced, presenting, as it does in the last regard, difficulties not found with any other scale insect." (l.c. pp. 9-10.)

Aspidiotus perniciosus belongs to the sub-family Diaspinæ of the Coccidæ. It is a small soft insect which secretes a scale separate from itself much like the shell of an oyster. This scale is very minute, round, flattened, and in the case of the male is "grayish, hardly black with a light dot and ring."

The illustration reproduced in the *Gardener's Chronicle* (Feb. 12, 1898, p. 103, figs. 37–40) will afford some idea of the appearance of the insect. In fig. 37 it is on a Californian pear and of the natural size.

Outside the United States the insect is known to occur in Australia, Chile and Hawaii. It is now spread throughout the States of Cali-

* The San Jose Scale: its occurrence in the United States, with a full account of its life history and the remedies to be used against it. By L. O. Howard and C. L. Marlatt. Bulletin No. 3. New Series. United States Department of Agriculture. Division of Entomology. With a map and numerous woodcuts, [Washington. Government Printing Office, 1896.]

fornia, Oregon and Washington, reaching British Columbia during the last few years. It has extended southward to Nevada, Arizona and New Mexico. In the Eastern States its occurence has in many cases been traced to two large New Jersey nurseries "from which infested plants had unwittingly been sent out for certainly six or seven years." The Southern States, such as Louisiana and Florida, appear also to be infected, but so far not to the same extent as the Western States. Altogether "the San Jose scale has in a few years gained a foothold in no less than fourteen States east of the Rocky Mountains. Its latitudinal range extends from 28° S. lat., to 50° N. lat.

As regards the plants attacked, it is stated that, "practically all deciduous fruit trees are subject" to its attacks; also "many shade trees and ornamental shrubs. The pear, peach, plum, apple and cherry are almost equally liable to injury"; also currant and gooseberry bushes.

All parts of the plants become eventually covered, giving them the appearance of a "grayish, very slightly roughened, scurfy deposit."

Various methods are suggested as remedies and preventives. A lime-sulphur wash is said to be used during the dormant season as a winter application; a resin wash both as a winter and summer wash, chiefly the former; while a kerosine emulsion is used in the summer only. In addition, there is the hydrocyanic gas treatment applied to nursery stock. In all cases of recent attack, and this is of special interest in this country, "the affected stock should be promptly uprooted and burned. No measure is so sure as this; and the danger of spreading is so great that this course seems fully warranted."

As precautionary measures the United States Department of Agriculture suggest the following:—

No orchardist should admit a single young fruit tree or a single cutting from a distance into his orchard without first carefully examining it and satisfying himself conclusively that it does not carry a single specimen of the San Jose scale; he should insist also on a guarantee from the nurseryman of such freedom. In addition, no fruit should be brought upon the premises wlthout previous careful inspection." (l.c. p. 66.)

As was naturally to be expected, all European countries receiving vegetable production, such as fruit, &c., from the United States have been keenly anxious not to introduce so serious a pest as the San Jose scale into their nurseries or orchards.

As far as England is concerned, according to an extract published in the *Gardener's Chronicle* of March 19, 1898, "Mr. Newstead, an authority on scale insects, is satisfied that the insect has not yet established itself in this country, either upon fruit trees or cultivated plants of any kind, whether grown in the open air or under glass, or upon indigenous plants." How long this immunity will last it is difficult to say.

In the meantime, according to a letter to the *Times*, from Berlin, dated February 3, an order has been issued by the German Government to control, by careful inspection, importation of all fresh fruit from America. When the same is discovered to be infected with the San Jose scale it is at once refused. The importation of windfalls, packing material and plants is entirely forbidden.

La Semaine Horticole for May 7, states, however, that "L'entrée des

fruits d'Amerique est prohibée en Allemagne, au moins temporairement."

According to the *Revue Horticole* for May 16, "Le gouvernement hollandais a interdit pour quatre mois l'entrée des arbres et arbustes, fruits frais ou secs, de provénance americaine. . . . . De son côte, le conseil fêdéral suisse vient de prononcer la même interdiction."

The contiguity of the Dominion of Canada to the United States, and the consequent greater danger of infection with which it is threatened, has led to the passing of a law by the Canadian Parliament prohibiting the entry of all nursery stock from the States. It regards an effective inspection of such stock as impossible. Hence the prohibition is absolute as in the case of Germany.

The following correspondence, communicated to Kew by the Secretary of State for the Colonies, indicates the strong position taken up by the Dominion Government in endeavouring to deal with the subject :—

COLONIAL OFFCE to ROYAL GARDENS, KEW.

Dowing Street,
May 6, 1898.

SIR,

I am directed by the Secretary of State for the Colonies to transmit to you, for your information, a copy of a despatch which has been received from the Governor-General of Canada with its enclosures, on the subject of the Canadian law prohibiting the importation of nursery stock from the United States entitled the "San Jose Scale Act."

I am, &c.,
(Signed) EDWARD WINGFIELD.

The Director,
Royal Gardens, Kew.

LORD ABERDEEN to SIR JULIAN PAUNCEFOTE.

Ottawa,
April 9, 1898,

SIR,

WITH reference to Your Excellency's despatch No. 42 of the 28th ultimo on the subject of an Act recently passed by the Parliament of Canada, prohibiting the importation of nursery stock from the United States, I have the honour to enclose herewith copy of an approved minute of the Privy Council explaining the considerations which led to the enactment of this measure and representing that present circumstances do not admit of any modification of its provisions.

I have, &c.,
(Signed) ABERDEEN.

His Excellency Sir Julian Pauncefote, G.C.B.,
&c., &c.

(ENCLOSURE).

EXTRACT from a report of the Committee of the Honourable the Privy Council, approved by His Excellency on the 7th April, 1898.

The Committee of the Privy Council, have had under consideration a paraphrase of a despatch Secret of March 28, 1898, and a despatch dated March 28, 1898, from Sir Julian Pauncefote, Her Majesty's Ambassador to the United States, intimating that some modification in the recent law prohibiting nursery stock from the United States is urged by the State Department of that country, owing to the disastrous effect on the interests of American dealers whose contracts are to be filled.

The Minister of Agriculture, to whom the said despatches were referred, states that the very serious depredation caused by the ravages of the San Jose scale in the United States of America, induced Canada, in self protection, to take immediate and extreme measures to prevent the introduction of the pest into the Dominion.

The Minister further states that 32 of the States of the Union as well as the District of Columbia are now known to be infected with this pest and that so alarmed are the authorities of the different States at the increase of this insect, which is acknowledged to be by far the worst enemy of trees which has ever been studied by entomologists, that many of the States are now for this reason actually passing legislation as drastic as possible in their circumstances, with the object of preventing the shipment of infested stock from State to State.

The Minister submits that, in the opinion of all entomologists who have studied the subject, inspection is insufficient; the Dominion entomologist claims that thorough inspection is impossible.

The Minister observes that the following sentence appears in the latest publication on the subject by the United States' Entomologist, Bulletin 12, New Series, United States Department of Agriculture, page 25:

"The insufficiency of inspection certificates has been insisted upon again and again."

The Minister further states that the San Jose scale has been found at a few localities in the province of Ontario, in one of the most important fruit growing districts of the Dominion.

That the Provincial Government of Ontario recognizing the serious nature of this pest, has passed legislation with a view to its eradication, which is confidently believed will soon he accomplished if no further introduction of the pest from abroad occurs.

That so important was immediate action for the protection of Canada's most important fruit industry, and so numerous were demands from fruit growers, fruit growers' associations, and others in all fruit growing sections of the Dominion, that the members of both Houses of Parliament, upon the introduction of the Bill, suspended the rules of the Houses and passed the Bill at once.

That this was done with the full knowledge that a number of Canadians would suffer in consequence of the sudden prohibition of all nursery stock, they having been agents for the distribution of this stock and in many cases having been paid for it in advance.

That the results of the Act were referred to on a subsequent date in the House of Commons, and the Members evinced a strong determina-

tion not to recede in any particular from their action in passing the Bill.

The Minister, under the circumstances, is unable to recommend that for the present any modification be made to the provisions of the "San Jose Scale Act."

The Committee of the Privy Council, on the recommendation of the Minister of Agriculture, advise that Your Excellency be pleased to submit an answer, in the sense of this Minute, to His Excellency Her Majesty's Ambassador to the United States.

All which is respectfully submitted for Your Excellency's approval.

(Signed) John J. McGhee,
Clerk of the Privy Council.
(*Kew Bulletin.*)

NOTES ON EXTRACT OF GINGER.

By T. H. W. Idris.

It is well known that alcoholic extract of ginger, commercially known as "gingerine," does not contain all the aromatic principles of the root, as most of the essential oil is carried over the recovered alcohol.

In the course of experiments to produce extract of ginger that would contain the whole of the flavouring and odorous principle, it was found that acetone was the most suitable solvent, boiling as it does at 56° C. and being miscible with water in all proportions. The apparatus used consists of a modification of a Soxhlet on a manufacturing scale. If some powdered ginger be exhausted in a Soxhlet with acetone, and afterwards with alcohol, we find that the whole of the aromatic and pungent principles have been removed by the acetone, showing that it compares favourably with alcohol as a solvent. The acetone extract does not appear to have lost any of its volatile oil in the process of recovery, as is so markedly the case when using alcohol, while the last trace of acetone is easily removed by agitation with a little water. This acetone extract is a dark-brown substance of a treacly consistency, intensely pungent and at the same time possessing a full ginger aroma, the quality of which largely depends on the variety of ginger used.

It is readily soluble in alcohol, forming a deep brown liquid. If steam be passed through the extract and then condensed, it carries over a quantity of the volatile oil with it. This oil floats on the surface of the condensed water, forming a yellow layer, and can be easily removed. The difference in aroma of the various kinds of ginger though noticeable enough when examining the rhizome, is much more apparent when dealing with the oils themselves, and in this way a method of distinguishing the variety of ginger used is obtained. The various tinctures and essences of ginger may be very conveniently and readily prepared from this extract without the usual loss of alcohol, and syrup may be flavoured with it by proper diffusion at a suitable temperature without the use of any spirit, and a further saving may be thus effected in manufacturing ginger-flavoured beverages.—(*American Journal of Pharmacy*).

FERNS: SYNOPTICAL LIST—LIV.

Synoptical List, with descriptions, of the Ferns and Fern-Allies of Jamaica. By G. S. JENMAN, *Superintendent, Botanical Garden, Demerara.*

2. *Danæa stenophylla*, Kze.—Stipites 10-18 in. l, erect, slightly scaly throughout, joints usually 3 ; fronds pinnate, 10 - 15 in. l., 5 - 8 in. w., somewhat narrowed both at top and bottom; naked or a few minute scales at the base of the ribs beneath; dark-green above, very light beneath, pinnæ spreading, consisting of a terminal and nine to a dozen lateral ones, which are 3 - 4 in. l., ⅔rd in. w., shortly stipitate, and cuneate rounded unequal and deeper on the upper side, at the base, the apex acute acuminate or cuspidate; margins sharply serrated in the outer part, but plain their greater length ; rachis slender, light coloured beneath, slightly scaly, margined at the top; veins close and fine, spreading almost horizontally, forked at varying points from the base outwards: fertile fronds reduced, the pinnæ 1½ - 2½ in l,, 3 - 4 li. w., stipites longer and jointed.

Plentiful in moist stony forests at 5,000 ft., altitude. More nearly allied to *alata* than any other Jamaica species, but from which the terminal pinna, which is rather larger than the rest, rachis not winged except at the top and jointed stem of the fertile frond clearly distinguish it. The pinnæ too are longer and more acuminate. Sometimes the fertile are as long as the sterile.

3. *D. elliptica*, Smith.—Rootstock erect; stipites cæspitose, erect, a span to a foot l. slightly furfuraceous or, at length, naked, with 2 - 4 nodes; fronds erect or spreading, ¾ - 1 ft. l, and nearly as much w., composed of 3 - 5 pair of lateral spreading pinnæ and a similar terminal one which are cuneate or rounded and shortly stipitate at the base, the apex acute, acuminate or cuspidate, 5 - 7 in. l. 1 - 1¼ in. w, or rather over, dark or light green, with a few minute scales on the ribs beneath; chartaceous, margins plain within, the outer part freely or faintly crenulate; veins nearly horizontal; mostly forked from the base; fertile fronds similar, but reduced; on longer stipites, with 2 - 4 nodes Hook & Grev. Icon. t. 51.

a var. *major.*—Rootstock erect, fronds larger, with 5 - 7 pinnæ to a side; 3 - 4 nodes to the stipes; veins more open.

b var. *repens.*—Rootstock prostrate or repent; nodes 1 - 2; pinnæ 4 - 6 to a side.

In moist forests, often very plentiful especially in Manchester, St. Elizabeth and Clarendon. The larger states of this approach *nodosa* closely in size and number of pinnæ, but are readily distinguishable by the nodes in the petioles. Their number varies in the different varieties, but they are never entirely absent. Having examined in the forests a very large number of plants, though the extremes are distinct enough, this character of the absence or presence of nodes seems to me the only certain character to rely upon for determinining the two species.

4. *D. nodosa*, Smith—Stipites erect, strong, 1 - ½ or 2 ft. l., without nodes, furfuracous; fronds 1½ - 2½ or 3 ft. l., 1 - 1½ ft.w.; pinnæ 6 - 12 or more, spreading, stipitate and rounded or cuneate and often unequal sided at the base, the apex acute cuspidate or acuminate, 6 - 10 in. l. 1 - ¾ in., w., very variable in shape; margins usually plain within, the outer part crenulate, sometimes serrate at the point, often somewhat repand; surfaces nearly or quite naked; rachis slightly furfuraceous; veins exceedingly fine and close, simple or forked; fertile fronds similar, but the pinnæ narrower.—Hook. and Grev. Icon. t. 51.

Frequent in moist woods among the lower hills and widely distributed. Usually a large and robust species but variable in the number size and form of the pinnæ. In all states however it may be recognised from *elliptica* by having no nodes in the petioles.

Sub-Order III, *Ophioglossaceæ.*

Sporangia globose, plain and destitute of a ring or crown, opening transversely to the base (bi-valved), or by a lateral vertical slit, biserial or clustered, free or connate in flattened spikes which are simply pinnate or paniculate; rootstock epigeous; vernation straight; fronds herbaceous, small or medium sized, the respective fertile and barren divisions entire, pinnate or decompound; vernation reticulated or free.

This sub-order differs from the two preceding by the vernation or evolution of the fronds being straight instead of coiled and crosier-like. It consists of the three small genera, one of which is usually regarded as monotypic; the other two having six to a dozen species each. The former ranges from India to Australia while the distribution of the latter two is general through the temperate and tropical regions of both hemispheres. The rootstock is in all cases permanent, but even in the tropics, in some instances the fronds which are naked, membranous or fleshy, are annual and die after a few months duration.

Sporangia united in simple linear spikes; fronds simple, forked or palmate; veins reticulated.

1. Ophioglossum.

Sporangia free in compound panicles; fronds compound; veins free.

2. Botrychium.

Genus I. *Ophioglossum,* Linn.

Sporangia united laterally, splitting transversely at maturity, biserial on flattened linear spikes which are ½–2 in. l., petiolaet solitary, or several, shortly or long-petiolate, springing from the common stem, at the base of the leaf-blade; leaf-blade simple, forked or palmate; membraneous; veins reticulated; rootstock small, fleshy and sometimes subtuberous.

This is a small genus of about a dozen species, many of which vary, and are perplexing to define the limits of. The majority are terrestrial, and grown in open places, such as meadows or highland

moors. Some prefer wet situations, and the sides of rivers where they are regularly inundated. Two or three tropical species are epiphytal and grow on trees. They are distributed throughout the temperate and tropical regions of the world and are about equally divided between both hemispheres.

Plants terrestrial: fronds entire; spikes single, erect.

1. O. nudicaule.

2. O. vulgatum.

3. O. reticulatum.

Plants epiphytal; fronds palmate: spikes several, pendent.

4. O. palmatum.

1. *O. nudicaule,* Linn. fil.—Rootstock small, descending sheathed with brown scales; stipites slender, erect $\frac{1}{2}$–2 in. l.; leaf-blade erect oblong or ovate-oblong, 1–3 in. l., $\frac{1}{4}$–1 in. w., shortly and equally pointed at apex and base, thinly membranous; veins copiously areolated, the larger series containing a smaller, a distinct vein forming a slender midrib spike single, slender, $\frac{1}{2}$–$1\frac{1}{2}$ in. l., on a slender erect petiole 1–3 in. l., continuous with the stipe–Eat. Fer. N. Am. pl. 81. *O. sarinamense,* Reich.

Variable in size. A much more slender plant than the two following, with uniformly ovate-oblong leaf-blades, which are the same form at each end, and slightly pointed. It is generally dispersed from the Southern United States to Brasil.

2. *O. vulgatum,* Linn.—Rootstock as thick as cord, creeping under ground, producing buds at intervals which throw out roots and leaves; stipes 1–2 or 3 in. l., erect; leaf-blade $\frac{1}{3}$rd. 1 in. each way, subovate, but variable in shape, acute pointed, the sides rounded at the base and suddenly contracted and shortly extended into the petiole, but not distinctly cordate; firmly membranous: veins copiously reticulated, with more slender divaricating venules or finer meshes within the larger areolae, no midrib; spike single, springing erect from the top of the stipe at the base of the leaf-blade, $\frac{1}{3}$rd.–$\frac{3}{4}$ in. l., on a stem 1–2 or 3 in. l.,–Hook. Brit. Ferns. t. 46. Eat. Fer. N. Am. pl. 81.

Abundant, forming extensive patches often several feet wide, on open slopes and ridges at 5,000 ft. altitude and higher; mature in December and January. This is found in the same habitats as *Botrychium ternatum,* under bracken on open moorland. The fronds are one or two from each bud-stock. Distinguished from *reticulatum,* to which it approaches nearer in the form of the leaf-blade than to *nudicaule,* by the large patches which it forms, the smaller size, firmer texture, and leaf-blades not cordate at the base.

The creeping horizontal cord-like rootstocks form a close net-work two or three inches deep under ground, and when the plants are pulled up by hand only the small thickened bud-stock is obtained; the former must be dug up with some sharp instrument. At a lower elevation plants are found intermediate between this and reticulatum.

3. *O. reticulatum*, Linn.—Rootstock small, incased in brown sheath-like scales, emitting numerous fleshy spreading roots; stipes erect, 2–4 or 6 in. l., broadened gradually at the top; leaf-blade sessile, or with a short petiole-like base, sub-ovate and acute at the top, or orbicular reniform, fully cordate at the base, often deeply, with rounded auricules, or subcordate-cuneate, thin and membranous when dry; veins visible, copiously areolated, the larger meshes containing fine ones, no midrib; spike single, 1–2 in. l., on a petiole 3–6 in. l., which is erect, and continuous with the stipe. Pl. Fil. t. 164. Hook. and Grev. Icon. t. 20.

Frequent from the lower hills up to 3,000 or 4,000 ft. alt., occupying grass-banks, meadows and similar places. The leaf-blade varies from suborbicular, the outer part rounded and the base deeply cordate with rounded lobes, to subovate, the outer part acutely pointed, the base less distinctly cordate, and tapering in the centre haft-like, but is much longer.

4. *O. palmatum*, Linn.—Rootstock short, fleshy, the crown clothed with pale dense tomentum; stipites 1½-2 li. thick, ½-1 ft. l. leaf-blades pendent, ½-1 ft. each way, V or W-shaped, palmate, the base cuneate, the sides curved and entire, deeply cut from the front towards the base into 2-4 or 5 lobes, which are 4-8 in. l. 1-2½ in. w., tapering outwards to the point; texture flaccid, fleshy, but membranous when dry; forming copious oblong hexagonal areolae, which are directed from the base outwards; spikes 3-6, or, perhaps, more, pendent, at short intervals along the top of the stipites, or rarely on the sides of the base of the leaves, 1-1½ or 2 in. l., on petioles ¼ or ½ in. l.—Pl. Fil. t. 163. Eat. Fer. N. Am. pl. 81. *Cheiroglossa*, Presl.

Infrequent, on trees in moist forests or overhanging rivers, from the lowest to nearly the highest elevations (6,000 ft). A peculiar and beautiful plant. The plants from the high mountain forests are coarser than those from the lower habitats. It grows in peat formed of the rootfibres of other plants, and often in a mass of several individuals together, sometimes in company with *Vittaria stipitata*. The fronds are three or four or more to each plant. The range is probably general as I have gathered it in most of the eastern parishes, and west as far as Manchester and St. Elizabeth.

Genus II. *Botrychium*, Swartz.

Capsules free and apart, globose, splitting when ripe to the base, biserial on short flattened spikes; fertile and barren divisions of the fronds alike pinnate, or more or less decompound; veins free; stipites springing from a membranous sheath, which crowns the fleshy rootstock.

There are about eight or a dozen species in this genus, which vary in character as do those of the preceding, and follow, likewise, generally, the same geographical distribution. In one form or other all but two or three are found on the American continent, though only the two following penetrate the tropical limits, and are there confined to temperate elevated regions. Both are deciduous, the fronds dying away when growth is matured.

Fertile division springing from near the base of the petiole.

1. B. ternatum.

Fertile division springing from the top of the petiole.

2. B. virginianum.

1. *B. ternatum,* Swartz; stipites erect, 1-4 in. l., leaf-blade ternate in a small state, regularly pinnate in a large, subdeltoid, biquadripinnatifid, 2-6 in. l. nearly twice as broad, naked, firmly herbaceous; pinnæ and pinnulae petioled equal on both sides, the former shaped like the whole leaf, ultimate segments 1½-5 li. b. rounded on the outer margin and finely toothed; rachis, costae, &c., flat, membrane-margined in the outer part; veins forked, very oblique, pinnate spreading; panicle shaped and divided much like the leaf-blade 1-5 in. l. and b., greatly overtopping the leaf, on a petiole 6-8 in. l.—Pl. Fil. t. 159. Eat. Fer. N. Am. pl. 20.

Common on open moors and slopes, often, or perhaps chiefly, under bracken (*Pteris aquilina*), at 5,000 to 6,000 ft. altitude, mature in December and January. Normally this is a much smaller species than the next, but it is sometimes found with fronds (produced without the fertile division) that are a span long and much more broad. They completely contrast however in their features. The broadly rounded segment of the leaf, and fertile division springing from the base of the petiole, are sufficient characters to mention to distinguish this.

2. *B. virginianum,* Swartz—Stipe erect, ½-1 ft. l.; leaf-blade membranous, naked, subdeltoid, 5-9 in. l. more broad, triquadripinnatifid, the parts regularly pinnatiform, pinnæ spreading or erecto-spreading, lowest pair largest, petioled, acuminate; pinnulae similar in shape, more or less decurrent at the base, pinnatifid to the winged costulae; tertiary segments 3-5 li. l. 1½-2½ li. b., acute, lobed or toothed, largest final segments a line or less w. and d.; rachis winged in the upper part, and costae nearly or quite to the base; veins simple or forked, pinnate in the more entire segments; panicle similarly shaped and divided, 3-5 in. each way, on a petiole 4-6 in. l., not much overtopping the leaf-blade.—Pl. Fil. t. 159. Hook. Gard. Ferns t. 29. Eat. Fer. N. Am. pl. 33.

Common in forests at 4,000-6,000 ft. altitude; mature in March and April. The usually larger size, acuminate and more finely cut divisions, and their texture, distinguish this at sight from the preceding. There are two fronds to each plant, one without and the other with the fertile division. As *ternatum* is confined to open situations, so this is confined to deep forest shade. In both the fronds perish after fruiting.

CONTRIBUTONS AND ADDITIONS TO THE DEPARTMENT.

LIBRARY.

Botanical Magazine. Sept. [Purchased.]
British Trade Journal. Sept. [Editor.]
Chemist & Druggist. Aug. 13, 20, 27. Sept. 3. [Editor.]
Garden. Aug. 13, 20, 27. Sept 3. [Purchased.]
Journal of Botany. Sept. [Purchased.]
Nature. Aug. 11, 18, 25. Sept. 1. [Purchased.]
Pharmaceutical Journal. Aug. 13, 20, 27. Sept 3. [Editor.]
Produce World. Sept. [Editor.]
Sugar Cane. Sept. [Editor.]
W. Indian & Com. Advertiser. Sept. [Editor.]
Sucrerie Indigène et Coloniale. Aug. 16, 23, 30. Sept 6. [Editor.]
Notizblat, Berlin Gardens. Sept. [Director.]
Konigl. Botanische Gart. und Museum, Berlin. 1897-98. [Director.]
Plantae novae Glaziovianae. II. Prof. Urban. [Author.]
Tropenpflanzer. Sept. [Editor.]
Extra-Beilage Tropenpflanzer. Liberia-Kaffee. [Editor.]
Agricultural Ledger 1898. No. 1. Calcutta. [Lieut. Governor Bengal.]
Madras Agr.-Hor. Soc. Annual Meeting, Jan.-Mar., 1897. [Secretary.]
Times of Ceylon. July 27. Aug. 4, 11, 18. [Editor.]
Tropical Agriculturist. Aug. [Purchased.]
Proefstation East Java. Inhoud ed Index van Mededeiling, 1-49. 1893-98. [Director.]
Proefstation E. & W. Java. Levenswijze en Bestrijding der Boorders. [Director.]
Agricultural Gazette, N. S. Wales. June. [Dept. of Agr.]
Report Bot. Gardens and Domains, N. S. Wales. 1897. [Director.]
Queensland Agr. Journal. Aug. [Secy. Agr.]
Sugar Journal, Queensland. [Editor.]
Agr. Journal. Cape of Good Hope. July 21. Aug. 4. [Agr. Dept.]
Central African Times. June 24. [Editor.]
Mauritius Revue Agricole. July 15 & 30. [Editor.]
Journal Jamaica Agricultural Society. Sept. [Editor.]
Report Connecticut Agr. Exp. Station. 1897.
R. Com. Agr. Depression. J. Lawes & J. H. Gilbert [Rothamsted Com.]
Valuation of Manures obtained by the consumption of foods for the production of milk. By J. Lawes & J. H. Gilbert. (Extract). *Journal R. Agri. Soc. Eng.* IX. i. 1898. [Rothamsted Committee.]
Sugar beet in the United Kingdom. J. Lawes & J. H. Gilbert. (Extract) *Journ. R. A. S. E.*, IX. ii. [Rothamsted Com.]
Rothamsted Experiments, Origin, Plans & Results. By J. H. Gilbert. [Rothamsted Com.]
Do. Plans and Tables. [Rothamsted Committee.]
Report Govt. Botanical Gards. Saharanpur & Arnigadh. 1898. [Govt. N.W.P.]
Report Govt. Horticultural Gards. Lucknow 1898. [Govt. N.W.P.]
Publications of the following Agricultural Experiment Stations U. S. A. [Directors.]

Arkansas.	Utah.
North Dakota.	Tennessee.
Rhode Island.	

Winter Wheat Ontario Coll. & Farm. [Minister of Agr.]
Report Dept. of Agriculture, Canada, 1897. [Director.]
Report Missouri Bot. Garden. [Director.]
Montreal Pharmaceutical Journal. Sept. [Editor.]
Report U. S. National Museum. 1895. [Director.]
Botanical Gazette. Sept. [Editor.]
Field Columbian Museum. Publications 24 & 25. [Director F. C. M.]
Ontario Bureau of Industries. Bulletin LXVII. [Dept of Agr.]
Proc. & Trans. Nova Scotia Institute of Science, 1896-97. [Librarian.]

Torrey Bot. Club Bulletin. Sept. [Editor.]
Boletim Museum Paraense, Brasil. June. [Director.]
Hawaiian Planter's Monthly. August. [Editor.]

SEEDS.

From Supt. R. Botanic Gardens, Trinidad.
Livistona Jenkensiana.
From Dr. Franceschi, Acclimatizing Association, California.
Tabebiua Donnelsmithii.
" sp. probably rosea.

PLANTS.

From Mrs. Zeledon, San Jose, Costa Rica.
Cattleya Dowiana.
Stanhopea sp.
Oncidium sp.

WOODS.

From Dutton Trench, Esq.
Red Wood.
Blind Eye or Yucca.
Cacoon Withe.
Mosquito Wood.
Red Wood.
Wild Orange.

HERBARIUM SPECIMENS.

From Dutton Trench, Esq.
Blind Eye or Yucca.
Mosquitoxylum jamaicense.
Red Wood.
From G. A. Douet, Esq.
Acacia tortuosa.
Canella alba.

[Issued 19th October, 1898.

New Series.] OCTOBER, 1898. Vol. V. Part 10.

BULLETIN

OF THE

BOTANICAL DEPARTMENT, JAMAICA.

EDITED BY

WILLIAM FAWCETT, B.Sc., F.L.S.

Director of Public Gardens and Plantations.

CONTENTS:

PRICE—Threepence.

A Copy will be supplied free to any Resident in Jamaica, who will send Name and Address to the Director of Public Gardens and Plantations, Kingston P.O.

KINGSTON, JAMAICA:

GOVERNMENT PRINTING OFFICE, 79 DUKE STREET.

1898.

JAMAICA.

BULLETIN

OF THE

BOTANICAL DEPARTMENT.

New Series.] OCTOBER, 1898. Vol. V. Part 10.

AGRICULTURE OF THE SUGAR CANE.—IV.

Extracts from "Sugar Cane, Vol. 1." by DR. WILLIAM STUBBS, Director of the Louisiana Sugar Experiment Station.

Edited by FRANCIS WATTS, Government Chemist Jamaica.

CULTIVATION OF CANE.

In previous chapters, detailed instructions have been given for the preparation of the soil, and the planting of the cane. If every operation has been performed carefully, the early spring will find the planter working hard to secure a stand. If his cane has been planted in the fall of winter, the early spring will find the young shoots struggling to penetrate the three or more inches of dirt with which the cane was covered in the fall to protect it against the winter's cold. The earliest work is to remove this excessive dirt, and permit an early and rapid germination of the cane. To this end, two furrows on each side of the row are reversed, and the extra dirt on the top of the cane removed with hoes. In practice, the hoes "find" the embedded cane and leave only a thin layer of dirt, well pulverised above them. By this treatment the canes, if good, are soon warmed into a vigorous germination, and continuous stands are soon visible on every row. Some planters "scrape" their canes before off-barring with the plough, preferring to maintain the established winter drainage through high ridges and quarter drains, until the approach of the usually dry weather of spring. Cane planted in the spring is not so deeply covered, and frequently gives a stand without the aid of off-barring and scraping. However, the efforts of the planter are mainly directed in early spring to the securement of a stand of cane, and his judgment, disciplined by experience, will frequently suggest the best methods to be pursued to attain this important end.

Having secured a stand of cane, many planters concentrate their next efforts to the encouragement of suckers, which develop with great rapidity

during May and June. Others pay but little attention to the encouragement of suckers, feeling assured that this natural process will go unaided and begin at once the work of fertilisation and cultivation. If the cane has not been fertilised at planting, the first application should now be made before the furrows are returned to the cane and the middles "bursted out." In applying the fertiliser, which is usually placed on both sides of the row in the open furrow made by the two-horse plough, great care should be exercised to see that it is well distributed across the narrow ridge of cane and throughout the open furrows. The proper distribution of fertilisers at this stage of the growth of cane may well be styled "broadcasting in the drills," and the latter should not be too deep, else some of the fertiliser may never become available. At this stage in the cultivation of the crop, many planters use the subsoil plough before returning the dirt to the cane. On either side of the narrow ridge on which the young canes stand, in the open furrow made by the two- horse plough, the subsoil plough is drawn by four mules, to the depth of six to ten inches.

The advantages of this subsoiling are not always clearly apparent. Before the invention of good pulverising turn ploughs, subsoiling was quite fashionable. To-day it is used in but few localities. Upon our alluvial soils, where drainage is of such prime importance, and in our climate of heavy summer rainfalls, subsoiling must be practised with judgment and skill, else injury to soil and crops may result. It is safer and perhaps better, to precede the cane crop with deep tap-rooted leguminous plants, and let them do the subsoiling. After the fertilisers have been applied and the subsoiling (where practised) performed, the soil is returned to the cane, and the middles broken out with a large double mould board plough, and quarter drains opened, Emphasis is laid upon the importance of cleaning quarter drains immediately after each cultivation, since a heavy rainfall, flooding even temporarily the field at this period of the growth of the cane, may inflict an injury upon the soil which may last through the season and materially lower the yield of the cane. Not only the tilth, for which all the previous operations of ploughing, etc , have been conducted for the purpose of establishing, will be destroyed, but the bacteria upon, whose activity the plant relies for food, will be literally drowned by the million and time will be required for their restoration. Many cultivations will also be necessary before the conditions known as "tilth" will be re-established.

Having returned the soil to the cane and split out the middles, the process of cultivation begins. It has not been very long since the two-horse and four-horse ploughs were the only implements used in cultivating cane in this State. Within the last ten or fifteen years the cultivator has been introduced, and to-day may be found on nearly every plantation. Many varieties are used, covering the double shovel, solid, and sectional disc patents. Since the cane rows are usually six to seven feet wide, these cultivators cannot reach more than three to four feet around the cane. Hence, the middles of the rows are worked with the two-horse and four-horse turn ploughs, or with the double mould board plough. A few planters still prefer the turn ploughs for all the operations of cultivation, and use them continuously for "off barring and throwing back the dirt," until the cane is laid by. The

first plan of combined cultivator and plough is partly right and partly wrong; the second one wholly wrong.

Experiments in different methods of cultivation conducted at the Sugar Experiment Station through several years have shown that the exclusive use of cultivators has annually increased the yield of cane over ten tons per acre, and the sugar product 700 pounds. The following is an outline of the method pursued, from the preparation of land to the lay-by of the cane. The land is broken "flush" with a large plough (now use the Disc Plough), pulverised with a harrow, and bedded with two-horse ploughs. The rows are opened with a double mould board plough, cane planted and covered, and the middles broken out with the double mould board plough. The quarter-drains are opened six inches below the middles of the rows, and ditches cleaned. At the proper time the cane is off-barred with two-horse ploughs, scraped with hoes, and when large enough is fertilised by scattering the mixture across the open furrows and narrow ridge of cane. The dirt is returned as soon as fertiliser is applied, the middles broken out deep and clean, and the turn ploughs sent to the barn to remain until the next season. The disc cultivator with the three small discs on each side, is used for throwing dirt to the cane at the first working, and the middle, or diamond cultivator for breaking out the middles. In the second and third cultivations, two middle discs replace the three used in the first and are set at such an angle as to throw the desired amount of dirt to the cane, and is followed each time by the middle cultivator, thus completing the work with the two implements. At lay-by, the large, or "lay-by," discs are used, followed by the middle cultivator, with its two front shovels removed. By proper adjustment of the two instruments, ridges of any desired height can be made and the cane properly laid by.

Some contend that insufficient dirt is thrown to the cane for the preservation of the stubble. In reply, the station would point to a most excellent stand of three-year-old stubble now growing on its grounds, which has been thus treated from planting, four years ago. (1.)

The rationale of this method will be apparent by a discussion of the principles underlying general cultivation of crops; and our soils and crops should not be exceptions.

If the work of preparation has been performed as described in a previous chapter, subsequent planting and cultivation are easy processes. If badly done, then subsequent cultivation is not, properly speaking, cultivation at all, but efforts in the direction of securing that tilth which a good preparation would have insured. An excellent preparation always secures tilth, and after cultivation should be simply a maintenance of this tilth.

Some of our readers may desire a definition of tilth. In reply, we would

(1.) With the cheap labour of the West Indies, there has been but little tendency to resort to weeding and tilling by means of implements. The methods of planting are better adapted to the use of the hoe than of draught implements. More attention might be given profitably to the use of implements.—F.W.

say that the word involves two principles, viz.: first, the maintenance of such conditions as will promote the most rapid and beneficial chemical changes in the soil, and second, the conservation of the proper amount of moisture.

The chemical changes in a soil are most complex. Formerly the soil was regarded as dead inert matter, totally devoid of life, and until recently there was no suspicion of living organisms within it, except the plants that emerged therefrom. But the up-to-date agriculturist now knows that every well cultivated and fertile soil is penetrated with living beings, in fact a living mass of matter. The mineral part of the soil is to-day regarded as the environment of living organisms, from which the latter may draw a part of its sustenance. While air, water, and mineral matter furnish the materials of plant growth, they must all be digested before they can be assimilated. The mineral matter of every soil must suffer complete disintegration before assimilation, and the only forces so far known capable of accomplishing this work are the secretions of the plants, the vital activity of rootlets, organic acids, and the influence of soil ferments or micro-organisms. It is well known that soil ferments are intimately associated with the rootlets of some plants, and hence the leguminous plants are selected for soil improvement. Hundreds of micro-organisms exist in every fertile soil; some are useful to vegetation, some are noxious. In butter making, it has been found that certain bacteria ripen cream, while others prevent, and the former are now specially prepared on a large scale in the laboratory of the chemist and furnished as bacteria No. 41 to the butter makers of the world. So in the soil it has been discovered that organisms favourable to the preparation of plant food are accompanied by others nearly allied, whose chief function is to destroy the work performed by the former. The object, then of science is to discover some process by which the former may be multiplied and the latter destroyed. Accompanying the ferments already mentioned, are sometimes found others of a pathogenic nature Epidemics among men and animals are frequently due to germs which preserve their vitality in the soil, and passing with plant structure, or into wells or springs, are thus conveyed to animals and men, producing disease. Typhoid fever, lockjaw, charbon, cholera, and by many malaria, now better styled "malaqua," are believed to be thus propagated The recent spread of charbon throughout the alluvial section of Louisiana, emphasized this fact. Every effort should be made to prevent infecting the soil with the germs of any zymotic disease. Cremation of dead carcasses, and the dejecta of living patients, are the best preventives. Health officials in cities have therefore wisely prohibited the use of sewage for agricultural purposes.

The attention of bacteriologists has been devoted almost exclusively to the study of nitrifying organisms of the soil, and these only in their relation to the collection and preparation of nitrogen as plant food. It is believed, however, by some, that all plant food of every character is the work of micro-organisms within the soil. The relatively high price for nitrogen (or ammonia) in our fertilisers has been the cause of the patient investigation of bacteriologists along the exclusive line of nitrifying and denitrifying germs. Nitrogen is the most costly in-

gredient of plant food. It is the most fugitive. Our largest supply comes mainly from organic matter which by a process of oxidation through the work of organisms, is converted into nitric acid. The salts of nitric acids, are extremely soluble, and if not utilised at once by growing plants, are washed out by heavy rains. Hence, a gradual development of nitric acid during the period of growth of plants, and the process by which this oxidation is accomplished, is called "nitrification." This oxidation is going on in every fertile soil, and when stopped, even though the soil be rich in vegetable matter containing nitrogen, the plants thereon must also stop growth.

The nitro-bacteria taking part in complete nitrification are of three distinct types of genera: First those which convert nitrogenous matter into ammonia. Second, those which convert ammonia into nitrous acid. Third, those which convert nitrous acid into nitric acid. Each are necessary to the complete transformation of nitrogenous matter into nitric acid, the form of nitrogen chiefly available as plant food. A complete demonstration of this transformation can be made in any laboratory by analyses of samples of the same soil, after the lapse of a month, the one sterilised and the other not. The unsterilised soil will always give the largest amounts of nitric acid. These ferments work together synchronously, each one waiting on the other.

It is the aim of every cultivator to maintain his fields in conditions most favourable to the development of these soil ferments, upon whose activity the abundance of his harvests so intimately depends. What are these conditions?

1. They are the most numerous and active near the surface, diminishing in quantity and vitality as one descends. Hence, surface cultivation required for all crops for maximum results.

2. Aëration—an abundance of air needed. The necessity of deep preparation or breaking of land to insure thorough aëration of soil.

3. A high temperature. The maximum activity is developed between 85 degrees and 100 degrees. We all know how rapidly plants grow when both days and nights are warm, and how they are checked by a fall of temperature.

4. The absence of light. While parts of plants above the ground require sunlight for their functional full activity, these soil ferments diminish in activity to the vanishing point as the sunlight intensifies. Hence shading the ground in any way enables them to work nearer the surface, and warm nights are more favourable to their development than warm days. Hence many plants make phenomenal growth during warm nights.

5. A certain amount of moisture. Excessive moisture must be removed by drainage, since it excludes air needed for nitrification, yet a certain amount is indispensable to these ferments. For the most rapid work, experience has shown that from one-third to one-half of the capacity of the soil is the proper amount.

6. Since the final action of these organisms results in nitric acid, it is necessary that there be present in the soil some base which can neutralize it and prevent its accumulation in the soil; killing the ferments

and injuring the growing plants. Some lands will produce neither ferments nor crops, while limestone lands are everywhere very fertile. Hence, small quantities of lime or some other base, are essential to nitrification.

7. The most essential condition of all, the presence in the soil of some organic matter containing nitrogen. If the soil be deficient in this, it must be artificially supplied in some form, stable manure, cotton seed and meal, dried blood, fish scrap. etc. The use of stable manure and compost as a manure is doubly valuable. They not only supply directly the plant food, but nitrifying organisms of a particularly vigorous character in great numbers, and the latter, when incorporated with the soil, together with their progeny, exercise their activity upon the inert nitrogen of the soil, when the more nitrifiable portions of the manure are exhausted. Hence, stable manure and compost produce fertilising results beyond what was expected from the quantity of plant food contained therein. Even our poorest soils are found by chemical analyses to contain plant food amply sufficient for remunerative crops, and this addition of "ferments" by the compost renders much of it available. It may be asked here whether much of the infertility of some of our soils may not be due to the absence of these ferments and, if so cannot they be supplied? In reply, I say, certainly. Different soils vary greatly in the quantity and vitality of these ferments, and frequently good results have followed the thin sprinkling of a rich garden loam over a poor field. This has been frequently done on reclaimed swamp lands, rich in vegetable matter, sterilised by long inundation. A dose of lime and a small quantity of ferment scattered over them, have quickly converted them into fertile soils.

But science has gone further and prepared the way commercially for another class of fertilisers which are now on the market. Professor Nobbe, Director of the Experiment Station at Tharandt. Saxony, is now preparing for the market "pure cultivation of the bacteria." The preparations consist of "colonies of the bacteria on agar gelatine enclosed in sealed bottles, each one of which contains organisms enough for half an acre of land." These preparations are diluted in water, and sprinkled over the soil, or over the seed to be sown, or diluted in water and then mixed with about fifty pounds of the soil, and the mixture scattered over the land. He has named the preparations from the roots of seventeen different legumes, "Nitragin," and they are for sale on the market.

Besides producing nitric acid from organic matter through nitric ferments, the leguminous plants, particularly our own cow pea and some cryptogams, have through the colonies of bacteria which infect their roots, the power of converting free nitrogen of the air into plant food, and it is also believed that other organisms which are capable of oxidizing free nitrogen of the air, exist in soils that are devoid of organic nitrogen.

As I have remarked, these beneficial bacteria are accompanied by ferments inimical to agriculture; e.g., a ferment has been discovered which will decompose nitric acid, and has been styled "denitrifying ferment." A study of this ferment has developed the gratifying fact

thas under favourable circumstances they are not propagated in such numbers as to prove destructive. From the above it can readily be seen how cultivation tends to maintain the conditions for rapid nitrification.

Many beneficial effects of cultivation can now be easily explained. We cultivate shallow because such a process not only prevents destruction of roots of the plants, an evil always to be avoided, but also because nitrification takes place in the upper layers of the soil, and by the act of cultivation the ferment is well scattered. Again, the temperature at which fermentation is most active is about 90 degrees to 100 degrees, and this temperature obtains in the upper layers of the soil. The action of the ferment is suspended at or about 50 degrees on the one hand, and 150 degrees on the other. It is destroyed by high heat and electricity; hence, when lightning strikes a soil, nothing will grow where it struck for some time afterward. The presence in small quantities, of lime, highly favours nitrification. Moisture in excessive quantities excludes the air and suspends the vital activities of the ferment; hence the necessity of drainage. The absence of moisture is equally as objectionable, and here the second object of cultivation promotes the first.

From these considerations it will be seen that frequent cultivations, provided no roots are cut, are favourable to rapid nitrification. Soils cultivated daily produce better than the same soils cultivated weekly, and the latter better than those cultivated less frequently.(2)

Besides the beneficial effects of rapid nitrification, other chemical changes of great practical value are induced by shallow and frequent cultivation. The soil is a great laboratory, and the chemical changes taking place there are complex and continuous, and frequent stirrings accelerate these changes and give increased available plant food. One practice must be emphasized here as both wise and expedient, i.e., of breaking the crust after every rain to let in fresh portions of air and to aid nitrification, but under no circumstances should it be done while soil is wet, since this destroys, rather than aids, the ferment.

The second object in cultivation is to conserve the moisture. On the approach of a drought, cultivators should be run very shallow and almost continuously. In this way the thin layer of earth removed from the great mass of soil is laid as a mulch on the surface, and the continuous upward movement of the water through the soil into the air, is checked just below the surface, and the roots of the plants can then appropriate it. The continuity of capillary pores is broken, and the water therefore passing into the air is arrested just below the surface, and is conserved for the use of the plant. Hence, cultivate continuously in dry weather. One other point: finely divided soils have the power (varying according to character from 15 to 23 per cent.) of absorbing hygroscopic moisture from the air, a not insignificant property in a

(2.) Hence the constant weeding with the hoe, as carried out so largely in the West Indies, exercises beneficial results beyond the mere removal of weeds. The surface soil being gently stirred, nitrification is accelerated, and at the same time moisture is conserved by the loosened conditions of the surface soil.—F. W.

prolonged drought with heavy dews at night. These are the reasons why we cultivate. With these reasons before us, the question may be asked, which best promotes the above changes and conditions, the cultivator which stirs only to limited depths and never inverts? or the plough which runs six to twelve inches deep, completely inverting the soil and frequently burying plant foods and ferments beyond resurrection for the growing crop? The plain and candid reply, is, the cultivator. Again, but little stress has been laid upon the damage done the cane by the frequent cutting of its roots by the turn ploughs, a damage often fatal to good crops, and recognised in the adage among our older planters "that the cane never grew until it was laid by."

It is almost impossible to estimate correctly the annual damage to the cane crop of this State by the use of turn ploughs in its cultivation. Happily the custom is fast disappearing, and the presence of the middle cultivator on our market, and its trial by many planters this year, gives promise of an early adoption of cultivators alone, as implements suitable for the cultivation of cane. ([3])

The element of cost in the use of plough and cultivator has been left to the last; because scientific and practical reasons were convincing without it. But in this day of strong competition between the new and the rapidly developing beet sugar industry and the ancient, but seriously imperiled, sugar cane planting and manufacturing, every possible economy will be practised. Only by the adoption of the most improved and economical methods can the tropical sugar cane be maintained in the race with beets.

A comparison of the cost of cultivating a thousand acres with the plough and with the cultivator, will show an enormous balance in favour of the latter. With two good cultivators and four strong mules, from four to ten acres (depending on width of row) of cane can be completely cultivated in a day, whereas, with ploughs two or three acres per day are reckoned goodly amounts. Again, hoeing, now such an expensive factor in the growing of a crop of cane, can be greatly reduced if not entirely eliminated (after scraping the cane) by the proper and rapid use of cultivators.

So strong are all the reasons, scientifically, practically and financially, for the substitution of cultivators for plough in the growing of sugar cane, that the assertion is made that all planters will ultimately use them, "if not to-day, they will to-morrow."

Cultivation of the Stubble.

Of prime necessity for securing a good stand of stubble is the burning of the trash as early after the cane is harvested as possible. The advantages of burning have been given elsewhere and need not be repeated here. After burning, provided the drainage is good, the cane rows should remain high and dry during the winter and ready for off-barring early in February. This latter operation is usually performed with two or four horse turn ploughs, the stubbles being left on a narrow

(3) Dr. Stubbs remarks must here be taken as applying to cultivation of growing canes and not to the preparation of the land for planting.—F. W.

ridge. Formerly the stubbles were dug with grubbing hoes down to the mother cane and left shaking in the breeze. Happily this custom has very generally disappeared and is now supplanted by the use of an implement called the stubble digger, which is run several times over the stubbles loosening and pulverising the earth, admitting air and heat and causing early germination in the buds. The stubble digger. when properly operated, is a most effective and economical implement. The rapidity with which it may be operated, covering ten to fourteen acres per day, coupled with the good work performed, makes the cost of digging stubbles very small compared with the old grubbing hoe method. Improperly handled, especially upon very old stubblea, injury may result from its use. Upon old ratoons on the station, it would occasionally pull up a stubble in spite of our best efforts, to prevent, thus injuring a future stand. However, the amount so injured especially upon first year stubble, is small and insignificant beside the great saving of cost in the work performed. (4)

(4.) The methods of dealing with the stubble, or ratoon canes, will naturally differ in a country like Louisiana which has a definite winter, from the methods followed in the tropics where growth in continuous and efforts are made to secure an early and rapid spring of ratoons.—F.W.

ENTOMOLOGICAL NOTES.

By J. E. Duerden, Curator of the Museum of the Institute of Jamaica.

The Army Worm in St. Ann.

The following communication was received by the Director of Public Gardens:—

Richmond Estate,
Laughlands, P.O.
8th August, 1898.

By to-day's post I send you 4 specimens of caterpillars that are destroying canes on this estate. You some time ago advised green dressing of "Cow Peas." I sent to America for two bushels which I planted in two fields of young plant canes. They bore abundantly, but to-day I noticed in one field in which the peas are not yet reaped, that about three acres of canes were completely eaten by caterpillars and there are hundreds of the kind sent on the canes. I fear I have introduced, with the peas, another insect pest. Can you advise me what to do? Please let Mr. Duerden see them. Unless stopped at once they will destroy the whole piece, as they evidently are increasing rapidly. The peas are not touched. I have been 15 years a planter and have never seen canes atracked in this way.

I have put on children to pick them off and destroy them and I am having the piece well cleaned, and the peas reaped. I shall be grateful for any advice you can give me.

Yours faithfully,
Fred. L. Clark.

Mr. Fawcett accordingly forwarded Mr. Clark's letter along with the specimens of caterpillars to the Museum. Upon examination the latter proved themselves to be closely allied to, if not absolutely identical

with, the well known "Army Worm," *Leucania unipuncta*, of America. The same caterpillar was the cause of considerable damage to guinea grass pastures last year, more especially on the south side of the island, numerous communications appeared in the press and were received at the Museum in reference to the matter. The present, however, is the first occasion on which complaints have been received this year. On exhibiting the specimens at a meeting of the Board of the Agricultural Society, it was affirmed by several of the members that the caterpillar is still present, though in much reduced numbers, in many of the localities affected last year. It is therefore necessary that attention should still be directed to the pest to prevent if possible its further excessive increase.

The Army Worm has been the subject of much consideration in America, where occasionally it develops in vast numbers, and causes great damage from place to place. The "Army" habit is assumed when the caterpillars occur in such numbers as to exhaust the supply of food in the field in which they hatch; they then begin to crawl along the ground in almost solid masses towards adjacent fields.

The caterpillar is found to be most destructive in seasons following years of unusual drought, and this condition was certainly exemplified in the case of Jamaica last year; the proper seasonal rains occurred after an intermission of two or three years had given rise to a most serious want of water. Again the Army Worm is found to be seldom injurious in a given locality for two successive summers.

When an outbreak is first noticed, and if confined to a limited area, it is generally worth while to cut down the grass infested. The worms will remain beneath its shelter for two or three days, and as soon as the cut grass is dry enough it should be burned, thus destroying the pests and preventing the invasion of neighbouring fields. It is difficult to apply any remedies which will save a field already infested. The worms may be destroyed by spraying them with strong kerosene emulsion; and when in vast numbers the construction of barriers, ditches, or furrows has to be resorted to in order to prevent their migration.

In a later communication Mr. Clark states that it was impossible to burn his piece of land infested, as the canes were young plants, just growing. He had, however, all the peas reaped and the field thoroughly cleaned and irrigated, and then put on a gang of children to pick off the caterpillars and destroy them. He writes that the field now seems free of them and is recovering from the attack.

Any similar occurrence elsewhere should be made known at once, when proper remedial measures can be indicated. It is also very desirable to obtain specimens of the adult moth, so that its specific determination can be carried out.

A Branch-cutting Beetle.

Examples of fallen brauches of various kinds of trees are often brought to the Museum one end indicating that the branch has been amputated by some gnawing or cutting action. In several instances a

stout, dark brown, longicorn Beetle has been found associated with the branches. In all cases the appearance is the same: the branch has been gnawed away in a circular somewhat rounded manner almost to the middle, and has then broken off by its own weight. Branches of over an inch in diameter have been severed in this way.

Mr. John Cooper. Giddy Hall, St. Elizabeth some time ago brought a branch of *Casuarina* in which this had been carried out. Mr. Arthur George has contributed similar specimens from the cotton tree, *Eriodendron anfractuosum*,, and from the Congo Pea, *Cajanus indicus*.

Specimens of the beetle and the branches were sent to Dr. L. O. Howard, Chief of the United States Department of Agriculture, and he has very kindly replied as follows:

"I have your letter of the 10th of December and the very interesting specimen of a Longicorn beetle and of its work. There is no doubt that the beetle is the cause of this amputation of the branches, as is indicated not only by its specific name, but by earlier references to the literature. My assistant in Coleoptera. Mr. E. A. Schwarz, determines it as *Oncideres amputator*, Fabr. The original descriptions make use of the following words: "Habitat in Americæ insulis ramos etiam crassiores abscindere dicitur" Fabricius, (Entom System. 1, 2, p. 276). The larva is described and figured by W. Kirby (Trans. Linn. Soc., XIII, 1821, p. 604; tab. 2c, figs. 1–4). I am glad to receive the specimens, which will be deposited in the U. S National Museum. We have in the United States four congeneric species, which have precisely the same habit. but they are smaller insects and confine their attacks to very much smaller twigs.

I am, &c.

L. O. Howard."

Other specimens in the Institute's Museum, such as *Lagochirus araneiformis*, are closely allied to the *Oncideres amputator*, and no doubt have the same destructive action on trees. It does not seem likely, however, that the loss of branches ever becomes so great as to be regarded in a serious light by the agriculturist.

Stink-bugs attacking the Irish Potato.

A short time ago Mr. J. G. Stewart, Westphalia, Guava Ridge P. O. wrote as follows of some insect attacking his Irish Potatoes:—I have planted some Irish Potatoes and they are just growing. Last week when I went to inspect the field I found these insects swarming upon nearly all the plants. Whenever the insects swarm in this way the plants always fade away and die."

On examination of the specimens accompanying the letter showed them to be one of the stink-bugs. They were kindly identified by Mr. W. H. Ashmead, of the United States National Museum, as *Spartocera batatas*, Fabr., who also states that it is a well known pest of the potato.

The stink-bugs belong to the order Hemiptera, which includes many

well known insect pests, such as the true bugs, lice, aphides or plant lice, and scale insects. They all gain their livelihood by piercing and sucking the sap of plants or the blood of other insects, their jaws forming a special sucking beak. In the stink-bug family the insect has a nauseous taste and odour, the latter being caused by a fluid excreted through two openings situated near the attachment of the middle pair of legs.

Spartocera batatas, Fabr. is a member of the family Coreidæ and is closely allied to the squash-bug, *Anasa tristis*, well known as a pest in America. The present species is a dark brown insect with bright yellow spots around its posterior lateral margin, and is about three quarters of an inch in length. The earlier stages of development display the bright yellow spots more distinctly than the adult. Both in the larval and adult condition the insect is to be feared, as by sucking the sap of plants they soon cause the death of the latter.

The remedies recommended for such insects as suck their food are the contact insecticides, kerosine emulsion or whale-oil soap. Where these can not be applied, it will be found best to institute a thorough picking of all the insects. They are large enough to be readily seen and handled and are sluggish in their habits. All the rubbish should be cleared off the ground and burnt.

The Sweet Potato.

Mr. J. V. Calder, Malvern, St. Elizabeth, has forwarded to the Agricultural Society samples of badly diseased tubers of the sweet potato, *Ipomœa batatas*. The tubers are found to be tunnelled throughout by a small footless grub or larva, about a quarter of an inch in length, while here and there are specimens of the quiescent pupal stage, and also of a Curculionid beetle. Examples of the larvæ have been kept and develop into the weevil This is dark blue, metallic looking, spindle-shaped behind, narrow and brownish in the middle, and the head terminates in a long beak. From all accounts the disease extends over a wide area, and the damage caused by the grub is very considerable.

At the United States National Museum, the weevil has been determined by Mr. W. H. Ashmead as *Cylas formicarius*, Fabr. Mr. Ashmead further adds that the species is a well-known pest of the potato and was imported from India, and is now found infesting the sweet potato in Florida and Louisiana.

It is very necessary that steps should be at once taken in Jamaica to check or thoroughly eradicate this pest of one of our important articles of food. The tubers are quite useless as food when infested with the grub. It is strongly recommended that all diseased tubers should be at once burnt, or in some way destroyed, so that no possibility remains of the larvæ attaining the adult condition and so continuing the species ; all rubbish on the ground should also be burnt to destroy whatever live weevils may be hiding amongst it.

Further, a rotation of non-tuberous plants, such as corn or cane, should be grown in order that the ground may become thoroughly clean. A somewhat similar disease amongst the sweet potatoes is known in the other West Indian Islands, and the rotation of crops has proved a most effectual remedy.

CO-OPERATIVE FARMING IN GERMANY.

A Consular Report on this subject, says the *London Standard*, has lately been issued by the Foreign Office, bringing into strong relief the causes which have enabled German so much more successfully than British agriculture to fight against depression. Some of those burdens which press so heavily on our home industry are unknown in Germany, while at the same time her farmers have enjoyed the benefit of Protection, which, however mischievous in its general effects, undoubtedly answers its purpose in the case of those for whom it is primarily intended. The Report has been received from Mr T. R Mulvany, our Consul at Düsseldorf, and is drawn up by an expert, Mr. F. Koenig, who is said to be specially well qualified for the purpose. They agree in attributing the most salutary effects to fair freights and moderate Protection. But Mr. Koenig brings together a great mass of evidence to show that other causes have contributed very largely to the same result, though he does not go so far as to say that these alone, without the other two, would have enabled the German farmer to prosper as he does.

State aid in Germany has been carried out on a scale wholly unknown in England. The State has founded Agricultural Colleges at many of the old Universites—at Berlin, Göttingen, Leipsic, Halle, Munich, and Bonn, among others; and where there are no Colleges there is a Chair of Agriculture, with Professors to lecture on the subject. Thus an amount of scientific knowledge has been disseminated among the German farmers which has qualified them to cope "with the dishonesty of dealers in cake, meal, seed, and mineral manures; has taught them how to feed their stock so as to produce either meat, milk, or muscle; and what quantites of nitrogen, phosphates, and potash a crop needs, and which must be replaced." Our expert assumes that the British farmer is deficient in this kind of knowledge. If so, it is a pity, since he can buy all mineral manures, cakes, and meal much more cheaply than his Continental rivals. While plenty of scientific agricultural knowledge exists in England, we fear that it is not diffused, but sticks fast somewhere among the capitalists. It is not, however, only the Agricultural Colleges at the Universities to which our attention is directed. By means of schools established all over Germany, and maintained or subsidised by the State, agricultural science is brought home to the peasant farmer. In Wurtemburg there is a special school for the training of farmers' sons. There are dairy and farriery schools. "One of the greatest of German institutions is the State Experimental Stations, established for the purpose of making experiments of all kinds, and for testing fodder, manure, seeds, &c., for farmers, at quite a nominal fee. There are some private establishments of the same kind, but the greater part are subsidised by the State. Even local Chambers of Agriculture receive State assistance, and travelling agricultural lecturers are also supported by Government. But the Report attributes even more to the principle of co-operation than to State education. "Co-operation is the German farmer's stronghold and bulwark, and he means to stand by it." It is of various kinds. There are co-operative Credit Banks, the working of which is fully explained in the

Report, co-operative dairies, co-operative steam ploughs, and co-operative drainage and irrigation. "Co-operation," says Mr. Koenig again, "has proved to be the key to success in Germany, and has saved many thousands of farmers from ruin."

The Banks conducted on this principle enable farmers to obtain loans on personal security only, the collective guarantee of all the members or depositors being considered sufficient. "Wealthy banking firms and rich capitalists were all willing enough to lend money on real estate if sufficient security was forthcoming; but personal credit is what German farmers wanted. It is indispensable to buy stock, mineral manures, cake, meal, seeds, tools, machinery, and to pay wages – in short, to run the business. All the Union requires is the co-operative guarantee of the members of the Co-operative Society, a body of men of recognised standing." As all the members are personally acquainted with one another, the risk is next to nothing. That the system is a sound one seems to be proved by the results of the audit. In February, 1897, the auditors reported that of 649 Banks in Wurtemberg, 450 were thoroughly satisfactory, 192 were satisfactory with room for improvement, and only seven were unsound. In Germany, the Government, by having the management of the railways in their hands. are able to arrange an equitable system of freightage, while, thanks to the co-operative principle, the farmer "can avail himself of the lowest freights on all the materials he requires, and on all products sent to market, by loading in quantities of at least one ton." Under this system preferential rates are in Germany "an immense advantage to the farmer, whereas in England they are dead against him, the advantages there being reaped by his foreign competitor." Mr. Koenig is surprised that this state of things should continue to exist in England, and also that English farmers do not form Co-operative Banks.

How much longer this ancient industry will retain its position, even in Germany, seems a little uncertain. It is already beginning to yield to time and fate and the competition of the New World. A large proportion of the soil is in the hands of peasant proprietors: some of it is let as in England: and a considerable extent, the property of the nobility, is farmed by the owners. The proprietor cultivates his estate with the labour of the peasantry, who are practically *ascripti glebæ*, receiving only a small modicum of wages in cash, and the rest in kind, being boarded and lodged at the landlord's expense. It seems to us that if the proprietors in Great Britain chose to do the same thing, and to work as hard as the Germans, they might not only improve their financial position, but regain much of their former influence. In Germany, though the fall in rents would indicate a decline in the returns from agriculture, this class of proprietors make their own rents, and "appear to thrive." They live the life of an English country gentleman. They shoot partridges, roe deer, and hares, and the sugar beet crops afford such excellent cover that the birds will lie till they are trodden on. But the exodus of the farm labourers has commenced in Germany, where more profitable industries are beginning to draw them from their native fields. The supply of labour is growing daily more scanty. Men are imported from Russia and Poland; and the increase in the number of women and old men em-

ployed in field labour shows that the pick of the peasantry are turning their thoughts elsewhere. It is important to observe that this tendency on the part of the rural population to gravitate towards the towns is not in Germany, at all events, owing to any difficulty experienced by the agricultural labourers in obtaining land. "The farmers are only too ready to let small holdings at a nominal rent, or to sell out a few acres to their men to induce them to remain in the country." But even this temptation fails to retain them. In Bavaria rather a curious custom prevails with regard to small holdings. "Land is not subdivided among the children of the family. As a rule, one of the children inherits the whole farm at a fair price during the life of the parents, when the latter reach their 'sixties.' The remaining children get 'paid out,' but retain the right of living in the honse if ill-luck meet them in life." Elsewhere, to prevent the evils of sub-division, the State has intervened, every parish being now empowered to take measures for reclaiming very small patches and bringing them back into one plot. "Every workman," says Mr. Koenig, "has the option of acquiring land and building his own cottage, and this very fact forms, socially and politically. the mainstay of the country." Yet, as we see, it will not keep the peasantry in the land.

Turning to live stock, we find that sheep farming in most parts of Germany is on the decline, owing to the fall in the value of wool. Cattle are kept chiefly with a view to milk and draught purposes. But in Westphalia, Mecklenberg, and Saxony sugar beet roots, in the language of the Report, seem to be "the order of the day." The difficulty with this crop is the number of labourers which it requires and the increasing scarcity of skilled hands, owing to the higher wages to be obtained in towns. Agricultural wages, vary, of course, in different districts. The ordinary labourer earns 1s. 9d. a day in Summer, 2s. a day in harvest, and 1s. 6d. a day the rest of the year. But then he gets a cottage free, a small plot of ground for potatoes, and another for linseed; and he has the use of the farm horses to work his allotment. Piece work is paid much higher; and in Saxony it seems that this system is the commoner of the two. Beer is one of the staple products of Bavaria, where great attention is naturally paid to the barley crop. It has been found that by careful selection of varieties, &c., the quality of malting barley can be greatly improved. The brewer then pays a higher price for it, and the farmer makes a profit where formerly there was a loss. Bavarian beer may only be brewed from malt and hops, and this regulation is enforced by very heavy penalties. Here, at all events, is something made in Germany which Englishmen may well covet. We have no space for all that the Report says of the reclamation of moorland and its beneficial results, which the writer thinks might be reproduced in Ireland. Nor can we more than mention generally what he says about the excellence of German agricultural implements. These "are as good as those of any country, with the exception of mowing machines and binders, in which the United States are first, and of steam ploughs and treshing machines, in which England excels." It seems, on the whole, to be the writer's opinion that if British farmers had the scientific knowledge of German ones they would be able to hold up against taxes, and railway rates, open ports and foreign competition. "We must never

forget that medical science at one time was revolutionised by chemical analyses and physiological studies, whereas in olden days medicine was practised much as a matter of routine, simply by experience. It is an incontestable fact that the chemical laboratories of the Agricultural Colleges have revolutionised agriculture. . . . Nowadays we know the chemistry of the soil, the plants, the live stock, the manures, the foods. Thus agriculture to-day is as much a science as in olden times it was a matter of purely practical experience." The Report concludes as follows:—

"The best foundation a State can give to its people is a thorough genuine and technical education, to fit them out adequately in order to be able to successfully fight their way; it affords them the best chance of being able to work against long odds, so that they may hold their own in bad times, and even through a crisis. The German farmer has had to fight against agricultural depressiou, but, by means of his thorough education and resources, backed up by science and State help, he has withstood bad seasons and low prices; he has been going ahead all the time, learning how to increase his crops and increase his income per acre in the same proportion as prices receded; with this object in view, no stone was left unturned, and his resources were strained to the utmost; he found great help in co-operation, as I have tried to show. Co-operation in credit, loans, purchase and sale of produce, purchase of foods, seed, mineral manures, in drainage and irrigation works of large dimensions, and in dairying. In all his struggles the State helped him, by encouraging scientific research at its experiment stations by gratis advice, and farmers recognised the value of unions and combined efforts to fight and swim up stream. He recognised that, single-handed, he was powerless to achieve anything, but, although not individually intrinsically wealthier when combined, he found himself, when united, and working hand in hand co-operatively, strong enough and able to withstand worse times than before."

In England State Aid has a bad name; and, though all classes are ready enough to take it when they can get it, most of them denounce it when offered to any but themselves. The prejudice, however, has its good side; and if the land were treated fairly in other respects, we doubt if English farmers would either require or desire such fostering care as is bestowed on their calling elsewhere. If a great industry like agriculture cannot rest upon its own bottom, there must be something wrong in the conditions under which it is pursued. Nor are we at all satisfied that the present Report makes out a case for German agriculture which political economy could approve.

FERNS: SYNOPTICAL LIST—LV.

Synoptical List, with descriptions, of the Ferns and Fern-Allies of Jamaica. By G. S. JENMAN, *Superintendent, Botanical Garden, Demerara.*

Order II.—*Equisetaceæ.*

Rootstock creeping; stems erect, cylindrical, longitudinally furrowed, jointed at intervals, hollow except at the joints, which terminate in a completely circular monophyllous dentate-margined sheath; branches simple, springing through the lower part of the sheaths, whorled or irregular, and spreading; no distinct leaves; fructification terminal on simple persistent or fugacious stems, in cone-shaped heads, which are composed of several horizontal tiers of peltate stipitate scales that bear

on their underside 6-9 pale membranous sporangia that open longitudinally in a slit on the inner side; spores minute, green, united to wool-like threads (elaters) that are spontaneously irritant while dry.

A single genus represents this order, numbering about twenty or thirty species, the principal part of which are spread through the north temperate zone, where they are, in several European countries, common and well-known marsh plants, which in Britain go by the name of horse-tails and paddock-pipes. In some species the barren and fertile stems are alike, in others they are different. They form no leaves proper, but these organs are represented by the membraneous sheaths of the joints. The branches are produced after the stems have developed, and they grow through the base of the sheaths.

Genus I.—*Equisetum,* Linn.

For characters refer to the order—

1. *E. giganteum,* Linn —Stems 4-6 or more ft high, ½ in. thick, stiff and erect; furrows very numerous (two dozen or more); sheaths whitish, ½ in deep, teeth as numerous as the furrows of the stems, acuminate, blackish with white scariose edges; ribs keel-like; branches numerous, virgate, spreading; furrows few (seven); sheaths corresponding in number of teeth; spikes apiculate, terminal on the twigs, 2-8 li. l, oblong or ovate; fertile shorter than the barren branches.—Sl. Herb. Brit. Mus.; Baker, Fern. Al. p. 4.

Infrequent in marshy places and by the sides of rivers, from the lowlands up to 3,000 or 4,000 ft. alt.; gathered on the banks of the npper part of the Yallahs river, above Pleasant Hill, first collected by Sloane, and again by Purdie, Wilson and March at the ferry, Morant Bay. The species is widely spread and variable in size and other characters, which has led to its having received several names. It is said in some instances to grow 20 ft. high.

Order III.—*Lycopodiaceæ.*

Stems erect prostrate or pendent, with terete or flattened branches, which are more or less repeatedly dichotomous (except in Phylloglossum) and leafy throughout; leaves relatively small, often minute, simple or forked, one-nerved, many seried and irregularly whorled, or, rarely, distichous; usually linear or subulate, close and imbricatng or more apart, rarely distant; sporangia bi-or trivalved, single, sessile and axillary in the leaves of the normal or modified branches, or in special spikes; spores of one kind, abundant and dust-like.

Four genera comprise this order, but only two of them are represented in this flora. The others, *Phylloglossum* and *Tmsipteris,* are confined entirely to Australia and the adjacent islands.

Sporangia 2–lobed.—Lycopodium.

Sporangia 3–lobed.—Psilotum.

Genus I. *Lycopodium,* Linn.

Sporangia reniform, one-celled, bivalved, axillary in the normal or modified leaves of the outer parts of the branches, or in the imbricating scales of special spikes; leaves of one or two kinds, multifarious, rarely distichous or biserial, generally close and often imbricating; stems and

branches mostly terete, dichotomously or pinnately branched, leafy throughout.

These are the true club-mosses, and their aspect, except in a few instances, is very different from that f their allies the Selaginellas, from which they are technically distinguished by having only one kind of spores and spore-capsules. They number about a hundred species, which are spread over the torrid and warmer regions of the globe, but most concentrated in the equatorial belt. Some of the species range widely in both the old and new worlds. They are divided in their habits of growth into two divisions—terrestrial and epiphytal, though in regard to some few species the line is not strictly drawn. The former grow in moist ground generally, either open to the direct sunlight or in forest shade. Two or three species, however, appear to prefer well-drained ground. Both are erect, or prostrate in growth, and more or less gregarious. Of the epiphytal, some are strictly pendent, others have a tendency to be pendent with tho gradual lenthening of their weak flexible branches, while still maintaining vertical growth. These generally grow in forests on the branches of trees. The spores of *L. clavatum* and *L. selago* are highly inflammable, and are sometimes employed under the name of vegetable brimstone in fireworks. Some few species are known to be purgative and others emetic

Fructification in dense, terminal, catkin-like spikes.

Spikes on slender peduncles.

Leaves dimorphous, branches flat with a distinct upper and under side.

1. L. scariosum.
2. L. complanatum.

Leaves all conform ; branches cylindrical.

3. L. clavatum.

Spikes sessile on normal branches.

4. L. cernuum.

Fructification in the unmodified outer parts of the branches

Leaves subulate.

5. L. verticellatum.
6. L. reflexum.
7. L. intermedium.
8. L. dichotomum.

Leaves broader.

9. L linifolium.
10. L. taxifolium

1. *L. scariosum*, Forst, var. *L. Jussiæi*, Desv.—Coriaceous, stiff, light-green and rather glossy above, paler and duller beneath ; stems terete, 2–3 or more ft. l., a line thick, stiff, prostrate, often forked from the base, clothed laxly with minute lacerate-edged leaves, distantly alternately pinnate ; branches pinnate ; branchlets forked 1–2 or more times ; divaricating flat, $\frac{1}{4}$in. w. $1\frac{1}{2}$–4 in. l.; leaves of two kinds, the larger superior, 2-serial, spreading laterally, $1\frac{1}{2}$ li. l. $\frac{3}{4}$ li. br. flat, close, spreading, oblong-dimidiate, the base adnate-decurrent, upper edge nearly straight, the lower up curved to an acute point; smaller inferior minute linear lanceolate, appressed to the underside, 2–3-serial, lax, pale and

scarious; spikes linear-oblong, cylindric, $1\frac{1}{2}$ in. l., more or less, in single pairs terminal on forked peduncles which are 3 in. or more l. from the base; bracts peltate, sub-deltoid or diamond shaped, acuminate, scarious-edged; sporangia cordate.—Hook. Icon. t. 126. Bak. Fer. Al. p. 29

Infrequent in moist places at 5,000 ft. alt., growing with sphagnum moss, gathered at Morce's Gap, near the Govt. Cinchona Plantation, the locality where Purdie and Bancroft previously gathered it. The American variety differs from the type by the long forked peduncles. The branches are flat, and spread flatly over the surface, with diffused growth. The lateral leaves are attached longitudinally, not transversely as in the other species, and the branchlets resemble fronds of *Polypodium trichomanoides.* The smaller leaves are exceedingly minute and confined to the underside.

2. *L complanatum,* Linn.—Stiffly coriaceous and rigid, light green; stems prostrate. 1–2 ft. l. or more, a li. thick, terete, clothed laxly or more closely with small subulate leaves; branches erect, or spreading, alternate fastigiate, rather flattened, repeatedly dichotomous; the final branchlets very numerous and crowded, linear, $\frac{3}{4}$–1 li. w. 1–$2\frac{1}{2}$ in. l. from the fork, convex above, sub-concave beneath; leaves of two forms: the larger lateral, keeled, concave entire, sharply cartilaginous-pointed, transversely adnate and decurrent, $\frac{1}{2}$ li. l. sub-deltoid; the smaller uniserial on both the upper and undersides, adnate and decurrent, narrow, entire, cartilaginous pointed, those of the former series larger and lanceolate-acuminate, filling the spaces between the lateral ones; posterior much smaller, subulate with vacant space around; peduncles 2–4 in. l., 1–3 from each branch, repeatedly dichotomous; spikes varying from two to upwards of a dozen together, $\frac{3}{4}$–$1\frac{3}{4}$ in. l. cylindric; bracts peltate, sub-deltoid cuspidate, the base rather cordate but also pointed; sporangia reniform.—Bak. Fer. Al. p. 28.

Abundant on open banks and waysides, often spreading over extensive spaces and covering the ground as densely as grass, at 4,000–6,000 ft. altitude. It may be readily recognised by the copious crowded narrowly linear branchlets, and numerous spikes. The latter are either in pairs or solitary on the final peduncles. All parts are very rigid. The lateral leaves of the branchlets are folded with a sharp angle and attached transversely, and adherent half their length. The intermediary ones are also adherent in like manner but narrow. Though in this and the two preceding, the branchlets appsar flattened, and the upper and undersides distinct and different the leaves are really all round them as in the truly cylindrical species.

3. *L. clavatum.,* Linn.—Stems repent, rooting here and there and branching laterally, 2–3 ft. l. cylindric; leaves lax, showing the stem between; branches erect; freely again branched but not in a dichotomous manner, densely clothed with leaves, which are in several series, rather stiff, subulate, $\frac{1}{4}$ li. w., $1\frac{1}{2}$–2 li. l. with a hair point, incurved; fertile branches 1–3 in. l., slender, terete, erect, with minute verticillate leaves at interval; spikes in pairs or alternate, 2–6 in all to a branch; bracts ovate-acuminate, attenuated, undulate-margined, somewhat spreading. Pl. Fil. t. 165 B. Baker, Fern. Al. p. 26.

A very stiff species, both in stems and leaves, but variable in its degree of branching in some cases lax, in others very dense, and having the branchlets short. The stems of the spikes are several inches high, and decrescent in size upwards, and thinly clothed with minute subulate leaves. The spikes have shorter pedicels from $\frac{1}{2}$–2 in. l. The leaves quite conceal the stems of the ordinary branches, though not of the primary and final ones In forest and half-open places at 3,000–5,000 ft. altitude it covers acres in uninterrupted extent in many places. *L. aristatum*, H. B. K. is the common American form.

4. *L. cernuum*, Linn.—Stems cylindric, strong, repent, thinly clothed with small linear-acuminate leaves, and throwing up at intervals erect pyramidal or plumose fertile branches, which are 1–1$\frac{1}{2}$ ft. high, with numerous tiers of spreading branches alternate in direction to each other, thus forming the plumose habit; these branches again freely branched with spreading branchlets, which are fertile at their tips; leaves in several series, dense, not flat, spreading and up-curved, $\frac{1}{8}$ li. w., 1 li. l. seta-like, main rachis clothed sparsely like the primary stem; spikes from a line to an in. l, 1–1$\frac{1}{2}$ li. diameter; bracts ovate-acuminate, the margins fringed. Pl. t. 163, Bak. Fern. Al. p. 23.

Readily recognised by its pyramidal or plumose habit, resembling young fir trees, each branchlet terminated by a pale coloured recurved catkin. These vary in length in the plants from different countries. In the local states they are from 1–6 li. l. so far as I have seen, but may perhaps be in some cases more, as specimens from Venezuela and Brazil have them from $\frac{3}{4}$–1 in. l. It grows both in shaded and exposed places, and on both wet and dry ground. In Guiana it reaches 8 ft high, supported by the bushes among which it grows.

5. *L. verticillatum*, Linn.—Stem erect, forked nearly from the base; branches erecto-spreading, many times dichotomous, leafy throughout, 1–1$\frac{1}{2}$ li. in diameter including the foliage; not decrescent outwards, or hardly so, stiff; final branchlets 1–1$\frac{1}{2}$ in. l from the fork, widely divaricating; leaves flat, stiff, straight, rather spreading, 1–2 li. l., subulate, whorled and close, in several series; fertile leaves rather widened at the base over the capsules, which are orbicular-cordate. Baker Fern Al. p. 14. *L. acerosum*, Sw.

Infrequent, terrestrial in shady places; gathered at Old England, near the Govt. Cinchona Plantations, at 4,000 ft. alt. Though the slenderest, this is the stiffest plant of this division. The leaves are larger than in *cernuum*, and flat stiff and straight, about $\frac{1}{6}$th of a line w. or less. The multi-forked branches rise to about 6 or 9 inches above the ground and extend laterally as much, forming low compact spreading plants. Of all the species it is one of the most freely branched, and the leaves are so inconspicuous that the plants appear to consist of little more than flexuose much forked diverging slender branches.

6. *L. reflexum*, Lam.—Branches erect, from $\frac{1}{2}$–1$\frac{1}{2}$ ft. high, repeatedly dichotomous, close and parallel, strong and rather stoutish, ribbed; leaves plain-edged or faintly serrated, reflexed, $\frac{1}{4}$ in. l. $\frac{1}{3}$rd.–$\frac{1}{2}$ li. w. broadest at the rather rounded base, linear-subulate, crowded, in several series; sporangia abundant, exposed, reniform $\frac{1}{3}$–$\frac{1}{2}$ li. w., much expanded Pl. t. 166. *L. reversum*, Presl. Baker Fern Al. p. 11.

A terrestial species, growing on open banks and other grassy places. The stems are erect, but as they bifurcate and lengthen they curve and. rest on the ground. It is a stiff species, but the stems are not rigid, being fleshy. While green they are 1–2 li. thick without the leaves.

7. *L. intermedium*, Spreng.—Branches slender, ribbed, distantly dichotomous few or several times, reaching 2 ft. long, the divisions relatively few, parallel or spreading more or less, not decrescent; leaves recurved throughout, 7-or 8-farious, linear-subulate, 2–4 li. l. $\frac{1}{4}$ li. w., very laxly arranged on the ribs; margins even or slightly serrated; sporangia about 1 li. w. reniform.

A more slender stemmed species than *L. reflexum*, of which Mr. Baker regards it a variety with longer interbranches, and smaller more recurved and laxer leaves. The branches are the same size and the leaves the same length from the primary stem to the ends of the branches. The top of the recurved leaves is turned quite round to the base, and thus they form nearly a circle.

8. *L. dichotomum*, Jacq.—Branches strong, leafy from the base, once to several times dichotomous, parallel or divaricating, firm, erect or spreading, ribbed; leaves 8-farious, close, rather crowded, linear-subulate, straight, or curved, spreading variously,- horizontally, deflexed or up-curved, often falcate, $\frac{1}{3}$rd–$\frac{1}{2}$ li. w. $\frac{3}{4}$–1 in. l., even-edged, purple at the base, not decrescent upwards, the outer ones often seeming longer but really not so; abundantly fertile, the sporangia cordate, much exposed.—Bak. Fer. Al. p. 16. *L. mandiocanum*, Radd.

Terrestial, near Blue Mountain Peak, epiphytal at low altitudes. The leaves are very close and spread in various directions, the outer of the branches often appearing to have longer ones than the inner parts, but it is only in appearance and due to the angle at which they spread. The species is a characteristic one, variable in its extent of branching, with a more or less upright (not pendent) but ultimately, as in *L. reflexum*, spreading growth. The leaves also vary in width, some plants from this cause having a much finer aspect than others.

9. *L. linifolium*, Linn.—Branches ribbed, very slender, leafy from the base of the primary stem, flaccid, repeatedly dichotomous, pendent, reaching 2 ft. long or over, final branches few or many, often very numerous; leaves lax, 3 serial, spreading, linear or linear-subulate, often rather falcate, $\frac{1}{4}$–$\frac{3}{4}$ or 1 li. w., $\frac{1}{2}$–$\frac{3}{4}$ in. l., herbaceous in texture, with a distinct mid-rib, even-edged; abundantly fertile, often from the inner bifurcations; sporangia fully exposed, reniform. Pl. t. 166. c., Bak. Fern. Al. p. 16. *L. flexibile*, Fée.

This differs from the two preceding species by its slender thread-like in size, branches, having the leaves only 3-farious, the flaccid texture, and loosely arranged leaves, between which the stem is visible from $\frac{1}{8}$ to $\frac{1}{4}$ inch. It is so pliant that a plant might be rolled into a ball between one's hands without injury. The var. of *L. taxifolium passerinodes*, as I have pointed out, in some of its states comes near it, but in that the stems are never so slender or flaccid, nor the leaves so few in series or so loosely placed on the ribs. Some specimens have nearly 100 final branches, all developed by repeated forking from a single primary stem. It extends from the lower hills to the high mountains.

10. *L. taxifolium*, Linn.—Stems ribbed, leafy from the base, pendent, spreading, or more or less erect, repeatedly dichotomous, from 6 in. to 2 ft. l., primary divisions spreading, or close and parallel as in the final branches, all decrescent or not outward; leaves close but not crowded, straight, linear-acuminate, even-edged, erecto-spreading, several-serial, flat, firm but not stiff, 1–1¼ li. w., ½–¾ in. l. very little narrowed at the transversely attached base; final branches fertile; sporangia reniform, copious.—Baker Fern Al. p. 16.

var. *L. passerinoides*, H. B. K.—Branches usually longer between the forking, more supple, always pendent, from 1–6 ft. l, decrescent outwards; leaves of inner stems as large, outer ⅓–⅔ in. l ½–¾ li. w., all linear-lanceolate; branches fertile often a considerable length.

Nearest *L. linifolium*, but with much stiffer and thicker stems and and firmer stiffer leaves. The habit of the type varies a good deal. Young plants are quite simple and erect, and grow either on the ground or on trees, though genereally on the latter; older plants have laxly spreading branches, while others again are quite pendent. The primary stems are ⅛ in. thick, and have 5–7 ribs, and consequently the leaves as they are attached to the ribs number the same series. The var. is marked by its more uniformly pendent habit, often much greater in length, (I have gathered it 6 ft. l., in forests at 6,000 ft. altitude,) and branches decrescent outwards, while some of its forms touch *L. taxifolium* on the one hand, others seem to pass quite into *L. linifolium* on the other. It extends from 1,000–7,000 ft. altitude.

Genus II. *Psilotum*, Swartz.

Sporangia sub-globose, trilobed, opening vertically down the centre of the lobes into three equal valves, axillary in the minute distant leaves; spores very minute, oblong, exceedingly copious; branches very slender, repeatedly dichotomous, trigonal or flattened; leaves simple or bipid.—*Bernhardia*, Willd.

This small genus consists of only two small species, which however make up for the paucity of type in their abundance and wide distribution. They are small twiggy plants; starting from a simple base, and repeatedly forking till they become a broom-like fascicle of twigs, with distant and very inconspicuous leaves.

Branches triquetrous.

1. P. triquetrum.

Branches flat.

2. P. complanatum.

1. *P. triquetrum*, Swartz.—Rootstock composed of few wiry deeply penetrating roots; stem few inches to a foot long, strong, wiry, erect or pendent, cylindric below, ribbed and angular above approaching the first furcation; branches triquetrous, with sharp angles, repeatedly dichotomous, decrescent outwards, forming a brush-like head, slender, virgate, short and stiff or longer and very flexile; leaves minute, simple or forked, at intervals in dentations on the edges of the branches; capsules in the axils of the leaves, 3-lobed. Bak. Fern Al. p. 30. *Lycopodium nudum*, Linn.

A more repeatedly branched bushy and stiffer species than the other,

easily recognised by the three cornered branches. The final branches are usually very numerous, about $\frac{1}{3}$–$\frac{1}{2}$ li. w. 1–2 or 3 in. l., sharply trigonal, fluted between the angles. The plants grow in fissures of rocks and between the roots of trees, the roots penetrating deeply. In some cases the branches are short and stiff with the capsules reaching to the ends; in others long and pliant extending much beyond the capsules. The capsules are like the fruit of many Euphorbiaceous plants in miniature—Hevea, for instance. It varies a good deal, and many species have been made by Karl, Muller, and other authors, of it. It is most common in the middle altitudinal region, but occurs quite frequently both above and below that range.

2. *P. complanatum*, Swartz.—Stems few to several in. l. cylindric at the base, becoming gradually triquetrous below the primary furcation, stiff or pliant; branches flattened, flaccid, repeatedly dichotomous, 1–1$\frac{1}{2}$ li. w., with a distinct midrib; leaves minute, $\frac{1}{4}$–$\frac{1}{3}$ li. l., hardly more, simple or forked, pointed, forming mere dentations along both margins at intervals of $\frac{1}{2}$–$\frac{3}{4}$ in. apart; capsules 2–3 valved, auxillary, dehiscent. Bak. Fern Al. p. 30.

Included on the authority of Swartz, who founded the species, but I have seen no local specimen myself. Grisebach included it in his Fl. B. W. I. Islands but had seen no specimen. However, as it is undoubtedly found in Cuba (Wright n. 947), the locality is not unlikely. Differs from the preceding by its flat 2-edged broader branches with a rib down the centre. It varies from 6 in. to 2 f. l.t in different parts of the world.

ADDITIONS AND CONTRIBUTIONS TO THE DEPARTMENT.

Library.

Annals of Botany. Sept. [Purchased.]
British Museum, Annual Returns. 1897. [Director Nat. Hist.]
British Trade Journal. Oct. [Editor.]
Chemist & Druggist. Sept. 10, 17, 24. Oct. 1. [Editor.]
Garden. Sept. 10, 17, 24. Oct. 1. [Purchased.]
Journ. Board of Agr. England. Sept. [Editor.]
Journal of Botany. Oct. [Purchased.]
Nature. Sept. 15, 22, 29. [Purchased.]
Pharmaceutical Journal. Sept. 10, 17, 24. Oct. 1
Sugar. Sept. [Editor.]
Sugar Cane. Oct. [Editor.]
Cantor Lectures. Plants yielding Commercial India-Rubber. By Dr. Morris. [Author.]
Flax Culture. By C. R. Dodge. [Author.]
Sucrerie Indigène et Coloniale. Sept. 13, 20, 27. Oct. 4. [Editor.]
Bulletin Koloniaal Museum, Haarlem, No. 19. July. [Director.]
Bulletin L'Herbier Boissier. Sept [Conservateur.]
Bulletino, Laboratorio ed Orto Botanico, Siena. Fasc. 2, 3. [Editor.]
Reports, 1895-96, Bot. Gardens, Old Calabar, Niger Coast Protectorate. [Curator.]
Times of Ceylon. Aug. 24. Sept. 1, 7, 15. [Editor.]
Tropical Agriculturist. Sept. [Purchased.]
Proefstation E. Java, Selectie van Suikerriet. [Director.]
Proefstation E. Java. De Mineerlarven van Suikerriet op Java. [Director.]
Agri. Gazette, N. S. Wales. July. [Dept. of Agr.]

Queensland Agr. Journal. Sept. [Secy. Agr.]
Bulletin Dept. of Agri. Brisbane. June. [Colonial Botanist.]
Queensland Sugar Journal. Aug. [Editor.]
Agr. Journal. Cape of Good Hope. Aug. 18. Sept. 1.[Agr. Dept.]
Central African Times. July 9, 16, 23, 30. Aug. 6, 13. [Editor.]
Mauritius Revue Agricole. Aug. [Editor.]
Journ. Jamaica Agri. Soc. Oct. [Editor.]
Bulletin R. Bot. Gardens, Trinidad. Aug. & Oct. [Superintendent.]
Proc. Agricultural Society, Trinidad. Sept. [Secretary.]
Synopsis, Meteor. Observations. May–Aug. St. Lucia. [Curator.]
Experiment Station Record, U. S. Dept. of Agri. [Editor.]
Univ. of Wisconsin, Bulletin No. 25. [Editors.]
Fern Bulletin. Oct. [Editor.]
Trans. Annual Meetings (1895-96.) Kansas Academy of Science. [Librarian.]
American Ginseng. George V. Nash. [Dr. True.]
American Journal of Pharmacy. Oct. [Editor.]
Publications of the following Agricultural Experiment Stations U. S. A. [Directors.]

New York (Geneva), 144. Kentucky, 76, 77.
Idaho, 14, 15. South Dakota, 58–60.
Texas, 46.

Montreal Pharmaceutical Journal. Oct. [Editor.]
Boletim, Inst. Agronomico, S. Paulo, Brazil. June. [Secy.]
Revista do Mus. Paulista. By Dr. H. von Ihering. S. Paulo, Brazil. 1897. [Director.]
Hawaiian Planter's Monthly. Sept. [Editor.]
Japan, Tokyo, Coll. of Agri. Bulletin, III, 4. [Editors.]

Seeds.

From Bot. Gardens, Demerara.
Castilloa elastica.
Manihot Glaziovii.

From Bot. Gardens, Hong Kong.
Sterculia lanceolata.

From Messrs. Reasoner Brothers, Florida.
Serenoa serrulata.

Herbarium Specimens.

Fsom J. Shore, Esq.
Canella alba. (Bark and leaves).

From Miss A. G. Roper, Unity Valley, St. Ann's.
Ornithidium vestitum.
Epidendrum rigidum.

From Mrs. Sewell, Arcadia, Trelawney.
Mirabilis Jalapa.
Euphorbia hypericifolia.
Eupatorium villosum,
Cassia emarginata. (Candle Wood).

[Issued 5th Nov., 1898.]

New Series.] NOVEMBER, 1898. Vol. V.
Part 11.

BULLETIN

OF THE

BOTANICAL DEPARTMENT, JAMAICA.

EDITED BY

WILLIAM FAWCETT, B.Sc., F.L.S.

Director of Public Gardens and Plantations.

CONTENTS:

PRICE—Threepence.

A Copy will be supplied free to any Resident in Jamaica, who will send Name and Address to the Director of Public Gardens and Plantations, Kingston P.O.

KINGSTON, JAMAICA:
Government Printing Office, 79 Duke Street.
1898.

JAMAICA.

BULLETIN

OF THE

BOTANICAL DEPARTMENT.

New Series.] NOVEMBER, 1898. Vol. V. Part 11.

GINGER IN JAMAICA.*

By F. B. Kilmer.

One of the essential requirements for the growth of this plant is sunshine.

Another requisite for growth—moisture—is also here in plenty. In some portions, 281 inches, or 23 feet, is recorded as an annual downpour. In the "ginger districts," 88 inches, or over 7 feet, has been the mean annual rainfall for the last twenty years. While ginger grows at suitable elevations all over the island, it is mainly produced in the central western portion, along the borders of the Parishes of Westmoreland, St. Elizabeth, Manchester, Clarendon, Trelawny and St. James. The underlying soil of this district consists of white and yellow limestone, with trappean formation; this is covered in some of the nooks or valleys with a pulverent mould or loam deposit several feet in depth. The plant grows luxuriantly in such soil, but apparently will not thrive in marshy soil, nor where there is present more than 10 to 20 per cent. of clay or 30 per cent. of sand. The government returns for the whole island give only about 250 acres of land devoted to ginger. This amount of acreage would not yield the crop harvested. But the real cultivation is not in acres, many cultivators having beds varying from 6 feet square up to the size of a building lot. A few cultivate from one to six acres. Large plots are very rare. For the most part, it is put in the ground in any convenient spot, alongside pineapples, yams, cocoa, cassava or other plants, often in the midst of a dense growth of bush or weeds.

In the statistics of this island this article does not figure in pounds, shillings and pence as largely as do some of its other products. Economically speaking, however, ginger is one of its most important articles

* Extracts from an article in the *American Journal of Pharmacy*, entitled "In the Land of Ginger—Jamaica."

of commerce. In my judgment, from 25,000 to 50,000 of its people are more or less dependent upon the ginger crop for such ready money as is essential to maintain their existence.

To the price or crop prospects, improvements in cultivation, difference in quality, the ginger planter gives little thought or care. He divides ginger into "blue" and "yellow" from the colour of the rhizomes. These are also known as, respectively, "turmeric" and "flint." I was unable to see any botanical difference in the plant producing the two different coloured root-stocks, and many intelligent planters were unable to distinguish the kinds without first examining the root. If anything, it seems to me that the blue was a degenerate species. The root of the blue is hard and fibrous, yields a much less proportion of powder, is less pungent, and therefore less valuable commercially.

There is also a division into "plant" and "ratoon" ginger. Plant ginger is ginger that is planted each season; "ratoon" ginger, is really a product of laziness. It is a return crop, secured by leaving a part of the "hand" containing a bud in the ground when the crop is harvested. Ratoon ginger is much smaller in size of hands than the planted, and loses each year in flavour, each successive crop being less and less in amount.

Ginger Planting.

Ginger is planted in March and April. The planting process consists in burying the divided fingers, each division containing an "eye" or embryo, in trenches or holes a few inches below the surface and about a foot apart, similar to the process of planting potatoes. The small grower simply digs a hole in a convenient spot. The thrifty planter first burns over his plot, to destroy weeds and insects, then ploughs and lays the plot out into beds and trenches.

The growing plant needs plenty of sun, and the weeds and bushes must be kept down.

This latter is a perplexing problem, unless the weeds have been destroyed before the ginger has been planted. If the weeds are pulled or the ground disturbed while the plant is growing, water is apt to settle around the roots, and this rots them.

The reed-like ginger plant, with its leafy stems, grows sometimes to a height of 5 feet; its cone-topped flowering stems reach from 6 to 12 inches, and in a well-cleaned field, make a pretty show when in their September bloom.

On wet soil and during very rainy seasons the root is subject to what is termed "black-rotten." This is a rotting induced by warm, soggy soil. The root swells in spots, fills with water, turns black, and emits an offensive odour. In this condition it is attacked by insects and worms which has given rise to the belief among the planters that the rotting is caused by a so-called ginger worm. (It is possibly a fungus disease).

Growing ginger must be well watered. Irrigation is practised to a limited extent, but in most of the parishes this is unnecessary, as the rainfall is abundant. Fertilisation, though highly important, is rarely attempted, partly owing to the small profit, but largely owing to the

customs of the country. The most that is ever done is to plough in the weeds and cover the ground with banana trash. . . .

An all-important feature is the rapid impoverishment of the soil that follows the ginger culture. One planter told me that only ferns would grow on the soil after exhaustion by this crop. There is thus a constant demand for virgin soil to secure the best-paying crops. This is attained by sending valuable timber up in smoke, as one authority tersely expressed it. "Dried-up streams, general barrenness, in fact a wilderness marks the progress of ginger culture."

An examination of the exhausted soil revealed the fact that it was deficient in organic matter, lime, phosphoric acid and soda. Attempts made, at my suggestion, to supply these deficiencies by the use of market fertilisers of various kinds were not productive of any favourable results. Stable manure alone resulted in a failure, as likewise did the use of a bat guano found in the island. The use of a marl, especially when mixed with stable manure, was a partial success.

The solution of the problem of reclaiming land exhausted by the ginger and other crops, and the prevention of the further wasteful destruction of valuable soil, is in Ginger Land one of great moment. There is in this fair island thousands upon thousands of acres of abandoned land, lying within easy reach of roads and ports; much of it has been abandoned because the soil has been exhausted by ginger or coffee. If by suitable tillage and manures it can be reclaimed, great benefits to the inhabitants will follow.

Ginger, as we know it, is the root-stock of the plant. The root proper or root fibres are about ½ inch long, not very numerous, dying off as the rhizome advances and leaving a slight scar. As regularly-shaped hands, with more or less straight fingers, command the higher price in markets, experiments were made to secure a regular-shaped growth. The fact was developed that a sprout starts from the parent eye, and from this stem, in turn, lateral shoots or branches develop in pairs. These side branches again develop in pairs, these pairs generally alternating to opposite sides. It was found that if the soil was well worked and pulverized before planting, the growth was straighter than when planted in hard soil. Some difference was noted also in the condition of the parent plant; if this was well developed and vigorous, the resultant root-stock was of a better type than where the parent was small, knarly and crooked.

Gathering the Ginger Crop.

Ratoon ginger is gathered from March to December, but planted ginger is not ready for digging until December or January, and from then until March is the "ginger season."

Ginger is known to be ready for harvest when the stalk withers. This begins shortly after the bloom departs. The rhizomes are twisted out of the ground with a fork. In this operation, every bruise or injury to the hands is detrimental to the market value. There is quite a knack in doing this, and it takes long practice to become expert.

The hands are thrown in heaps, the fibrous roots are broken off, and the soil and adherent matter removed. This must be done quickly after removal from the earth, for, should the ginger be dried with the soil and roots still adhering, the product would not be white, and, if it

lies in heaps before drying, it will mould. The custom is to throw it immediately into a dish of water; it is then ready for the uncoating or peeling operation; this is done by hand. . . .

Peeling Ginger.

Ginger-peeling is an art, and there are many expert peelers in Jamaica. The ginger knife is simply a narrow-edge blade riveted to the handle. In large operations an expert peels between the fingers of the hands, less experienced hands peeling the other portions. Examination of a transverse section of ginger will show the importance of the operation. There is an outer striated skin under which there are numerous layers of very thin-walled cork cells. This layer contains numerous oil cells, the oil cells being most numerous at the bud points. The oil contained in these cells, in specimens fresh from the ground, is almost colourless, very pungent and exceedingly aromatic. It becomes yellow very quickly on exposure to the air, and even upon drying without removing the epidermis, its delicate aroma is found to be fleeting. On drying the ginger the contents of these cells appear as yellow, pithy mass. (It has been stated that this colouring matter is identical with that of Curcuma). As this cork layer is the seat of the greatest amount of oil and resin cells, it will readily be seen that the deeper the peeling so much the more of these substances will be carried away with the epidermis, and more cells opened from which these principles may be excluded.

As fast as peeled, the roots are thrown into water and washed. The purer the water and the more freely it is used, the whiter will be the product. Generally a very little water washes a great deal of ginger. The hands are peeled during the day, and allowed to remain in the water over night. This water acquires a slimy feeling and, if concentrated, becomes mucilaginous and acquires a warm and aromatic taste. The natives claim that this process soaks out the "fire and poison" from very hot ginger. I placed some pieces in a stream of running water for twelve hours and succeeded in making them several shades lighter in colour. This sample proved to be less pungent to the taste, and it is quite possible the force of the water carried away some portion of the aromatic principles.

A few planters use lime juice in the wash water. This gives a whiter root, having some solvent action on the colouring matter, but, as the lime juice contains saccharine and pectose matter, it prevents drying, and mildew follows. In another experiment I supplied the natives with citric acid, vinegar and acetic acid. They all worked fairly well, citric acid being the best whitening agent, but it was reported that the process was expensive and troublesome.

It is generally stated that ginger is deprived of its coat by being plunged into boiling water before being scraped. This practice is not used to any extent in Jamaica. Its effect is to swell the starch and bassorin-like gums. I found that after keeping the freshly-pulled root-stocks in boiling water for an hour they were considerably swollen and the steam was filled with the aroma of the ginger. Under this treatment the coating comes off easily; but if the action of the boiling water is prolonged, the starch and fibre are acted upon, the product dries hard

and the colour is darkened. In fact, what is known as "black ginger" of the market is the result of this process. Ginger is found in the market coated with calcareous matter, such as carbonate of lime, etc., this is said to be to fill a demand for "white ginger." Such a proceeding is apparently unknown among the planters. Well-cured ginger has a decided white coating and that is all they know about it.

I tried chlorine gas as a bleaching agent, but at best the product was of a dirty yellow colour. By using the fumes of burning sulphur, the whole being partially enclosed in glass the heat of the sun aiding in the experiment, the ginger was whitened and mildew prevented. I found on trial that it might be of service to place the ginger in a weak solution of chloride of lime before drying; this would aid in bleaching and prevent mould.

Curing Ginger.

After washing, the process of drying follows. The tropical sun is the drying agent in all cases. Large operators have what is called a "Barbecue." This is a piece of ground several feet square, levelled off and laid with stone and the whole coated with cement. It is placed so as to receive the greatest amount of sunshine. The small planters use what is called a "Mat," consisting of sticks driven into the ground, sawbuck fashion, and across these sticks are laid boards, palm, banana or other large leaves; oftener than otherwise, the place for drying is a few palm leaves spread upon the ground.

Careful handlers put their ginger out as the sun rises, and turn it over at mid-day, taking it in at sundown. Rainy or cloudy weather invites mildew. It requires 6 to 8 days for the root to become thoroughly dry. I made several tests to ascertain the loss in weight by drying in the sun, and found the average to be nearly 70 per cent.

Ginger dried in the sun for the market examined for moisture gave the following results:

Six samples, well-dried specimens, showed a further loss when dried at 100°C. as follows: 7·2, 8·5, 8·9, 9·5, 10, 11, 12 per cent.

Several poorly-dried specimens, some of which were damp and mouldy, gave from 15 to 26 per cent. moisture when dried at 100°C. During the progress of my attention to this subject, several attempts were made to utilise artificial heat in drying ginger. Such a course would, in some respects, be a very desirable one.

In a portion of the island given almost entirely to the cultivation of this product, a few years ago a wet season prevailed. It was impossible to dry the crop in the sun; as a consequence there was a loss of crop, followed by considerable distress among the planters.

During my observations an attempt was first made to dry without removal of the skin coat. This, if successful, would have meant the saving of considerable labour. The product was quite dark, the flavour not as good as that of the sun-dried. By removing a part of the coat the drying was hastened. Dr. A. G. McCatty, a practising physician and owner of a plantation, at my suggestion, placed in operation an American fruit evaporator. It was necessary to use wood as a source

of heat and, partly owing to the high temperature and partly from the ignorance of the operator. the product so far has been rather poor in quality, the colour many shades darker, much of the aroma was lost, and a smoky, burned flavour acquired.

My conclusions were that, when well conducted, the native method of careful peeling and curing in the sun would produce a handsomer and a better product than any process yet suggested.

These observations were not undertaken with a view of making any complete analysis, and it was found that a macroscopic examination by expert judges was far more reliable than any assay that could be made with limited facilities present in the ginger fields

In these experiments some observations were made that were interesting, though of no particular value. In the extracts from ratoon ginger there was evidently a more fiery taste and less flavour than in the planted ginger. This was also true in regard to the extracts from the blue and yellow varieties, the yellow having a much finer odour and taste. Upon the addition of water to these extracts in sufficient amounts to precipitate the dissolved resins, it was observed that in the case of the well cured specimens of plant ginger a delightful aroma was imparted to the water, a true ginger flavour, without fire or pungency. But in extracts from old ratoon ginger, from mildewed specimens spoiled in drying, this aroma was greatly changed, becoming musty and weak, the taste in some instances being decidedly bitter. Ninety-five per cent., alcohol was found to give better results as to the flavour of extract than that of lower strength.

In the Ginger Market.

The highest grades are large-sized hands of light and uniform colour, free from evidence of mildew. This grade is brittle and cracks easily, but broken pieces depreciate the value. Buyers also require the hands and fingers to be firm and full, without wrinkles or spots. They generally assort into four or five grades, that which is shrivelled and small being the lowest. The dark varieties form another, the heavy, tough and flinty a third. These four are finally assorted by placing hands which are small but of good texture and colour as one grade, the larger-sized, well-bleached hands into the highest grade.

The ratoon finger sorts generally bring the lowest price, as they are small, soft and soggy, and lack flavour. Ginger gathered green shrivels much in drying. and is less aromatic and pungent than when fully matured. Ginger that has mildewed is spotted, and the mildew starts a decomposition that affects the flavour. Ginger put in bags or laid away before being thoroughly dried will mould and acquire a musty odour and flavour, which it is impossible to remove.

The largest sized hands are carefully selected by buyers and shipped to special markets, usually to England. I noticed hands weighing as much as eight ounces; many of them weighing from four ounces upward.

Ginger is packed in barrels for shipment.

Economics.

The amount of ginger exported from this Island during the last ten years is shown in the following table:—

		Pounds.
1887	...	1,121,827
1888	...	1,141,877
1889	...	1,002,653
1890 (½-year)	...	554,193
1891	...	1,219,197
1892	...	1,822,531
1893	...	1,526,884
1894	...	1,672,384
1895	...	1,736,460
1896	...	1,960,609

The yield and profit of the ginger crop depend somewhat upon the nature of the soil. In favourable seasons rainfall, sunshine, planting, care and curing, are also factors. An average yield can be estimated at from 1,000 to 1,500 pounds dried ginger per acre. In exceptional cases, 2,000 pounds have been gathered. There are planters in Jamaica who plant ginger here and there in patches, and gathering as little as a hundred pounds in a year. Ginger is well adapted to the small planter, and admirably suited to the peasantry of Jamaica, who by slow evolution, are passing from serfdom to manhood and independence.

The exact cost of producing this crop is difficult to calculate. The present output is largely the product of domestic labour, whose value is hard to compute; when this class of labour is hired, it becomes very costly. The figures in the following table are approximate only; as now conducted there is chargeable against the crop the item of rent or tax, (if the cultivator is an owner), the labour is mainly that of the family.

An approximate estimate of the expenditures and receipts on an acre of land planted in ginger are as follows:

Ground-rent or tax	...	$ 5.00
Clearing land, ploughing and planting		40.00
Cost of plants	...	50.00
Digging and preparing	...	15.00
Peeling	...	45.00
Drying	...	25.00
Delivery at market	...	10.00
		$190.00
Fertiliser (if used)	...	50.00
Superintendence	...	20.00
		$260.00

Yield: 1,500 to 2,500 pounds (cured ginger), at 12 cents per pound' $180 to $300.

Viewed from this standpoint, the cultivation of ginger on a large scale would be far from remunerative.

TOBACCO IN THE UNITED STATES.*

A bulletin by Mr. M. Whitney, Chief of the Division of Soils of the U. S. Department of Agriculture, gives a brief review of recent literature on tobacco, statistics of tobacco production in the different tobacco-growing districts of the United States, meteorological conditions in the great tobacco regions, and texture and water content of typical soils of the various tobacco-growing districts.

The conclusion is drawn that there is not sufficient difference in the meteorological conditions in the different regions, as ordinarily recorded, "to explain the distribution of the different classes of tobacco, yet this distribution is probably due mainly to climatic conditions . . . .

"One must still judge, so far as the climate is concerned, mainly from the experience of others as to the class of tobacco to be raised, as the ordinary meteorological record will be of very little value in determining this point. The plant is far more sensitive to these meteorological conditions than are our instruments. Even in such a famous tobacco region as Cuba, tobacco of good quality can not be grown in the immediate vicinity of the ocean or in certain parts of the island, even on what would otherwise be considered good tobacco lands. This has been the experience also in Sumatra and in our own country, but the influences are too subtle to be detected by our meteorological instruments.

"Little therefore, can be said at the present time in regard to the suitable climate condition for tobacco of any particular type or quality."

Next to climatic conditions the class and type of tobacco depends more largely upon the character of soil than upon any other condition. The present bulletin reports and discusses mechanical analysis of a large number of samples of soil and sub-soil collected in the more important tobacco districts, and also gives records of determinations of the moisture content during several years "in one or two localities in some of the principal tobacco districts."

The results show that the cigar tobacco soils of the Connecticut Valley contain on an average considerably less than 5 per cent of clay and maintain on an average about 7 per cent of water throughout the season. "These soils are too light in texture for any of the staple farm crops. They are adapted to the quick-growing spring vegetables. The conditions seem to be peculiarly adapted to a particular grade of wrapper leaf tobacco." Attention is called to the fact that a few years ago, when there was a greater demand for heavier cigars, these light soils had little or no value for tobacco, the tobacco being grown mainly on the heavier soils and on the "meadow lands" of the Connecticut Valley. These meadow lands differ from the light tobacco soils now cultivated principally in containing a larger proportion of silt, which enable them to maintain a water content of from 23 to 27 per cent.

The tobacco lands of Pennsylvania, which are also devoted mainly to growing cigar tobacco, are confined chiefly to a comparatively narrow belt along the Susquehanna River and to the lime stone soils, "typically developed in York and Lancaster Counties." The amount of clay in

* Tobacco Soils of the United States, M. Whitney. (U. S. Dept. of Agri., Division of Soils Bul. 11, pp. 47, pls. 13.) Review in *Experiment Station Record*, **IX, 11, Edited by Dr. A. C. True, &c.**

these soils varies from 13.8 per cent in the river soils and shaly limestone soils to 29.27 per cent in the pure limestone soils. They maintain on an average about 18 per cent. of water, the amount rising to 22 to 23 per cent. in the heaviest limestone soils. The best wrapper leaf is produced on the lighter soils.

"The cigar tobacco district of Ohio is situated in the south-western part of the State and includes the country bordering on the Miami River, Montgomery, Darke, and Preble counties forming the centre of the district. The soil is derived from drift material which has been worked over and modified by subsequent action of water." A typical soil from this region was found to contain 44.01 per cent. of silt and 27.52 per cent. of clay. It thus appears that the soils of this district are as heavy in texture as the limestone soils of Pennsylvania. During the season of 1897 they maintained a moisture content of a little more than 27 per cent. "It is probable that the mean water content of these soils in an average season would amount to about 23 to 24 per cent. of water. The tobacco grown under these conditions is used almost exclusively as a filler leaf.

"The Wisconsin tobacco is used both as a wrapper and filler leaf to some extent." It is grown on soils a typical sample of which was found to contain 36.05 per cent. of silt and 22.76 per cent. of clay. No determinations of the moisture content of these soils have been made.

The Cuban type of cigar wrapper and filler and some Sumatra tobacco are grown in Florida, especially in western Florida, although a new tobacco district is being opened up in the region of Fort Mead, on the peninsula. The tobacco lands of western Florida are "a light loam about 12 in. deep, resting on a heavy red clay, which is naturally well drained. The hammock soil of Fort Mead is, on the other hand, a very light, sandy soil, extending down to a very considerable depth." The red subsoils of Western Florida contain about 30 per cent. of clay, but maintain on an average only about 8 or 10 per cent. of moisture. The hammock lands "contain on an average less than 4 per cent. of clay and less than 6 per cent. of silt, fine silt, and clay. They contain over 50 per cent. of fine sand, so that they are relatively rather coarse and open. Notwithstanding this open texture. . . [they] contain an average 8 per cent. of water throughout the season, which is about as much as the tobacco lands of the Connecticut Valley contain. This water content, moreover, is for some reason more uniform, and the land can go for some time without rain with no serious injury to the crops. Nevertheless the planters have been greatly benefited by judicial systems of irrigation through overhead sprays. By thus keeping the plants continually and rapidly growing the crop will mature in 45 days from the time the plants are set out."

The soils of the cigar tobacco districts which are being developed in Texas and Southern California have not been thoroughly studied, but the analyses which have been made indicate that the soils "agree very well with the finer grades of cigar tobacco lands. The general climatic conditions, however, are different."

"The bright yellow tobacco used for cigarettes, plug wrappers, fillers, and cutting is grown mainly in Virginia, North Carolina, South Carolina, and East Tennessee. The typical bright tobacco land consists of a loose, porous sand, containing not more than 8 or 10 per cent. of clay.

This sand must be at least 12 in. deep. Many areas are cultivated in which the sand extends to depth of 5 or 10 ft. or more, and a very fine quality of tobacco is produced."

The average of analyses of 44 samples of bright tobacco soils shows that they contain about 8 per cent. of clay. They maintain on an average about 7 per cent. of water

"Where the soils contain less than this the leaf inclined to be finer in texture and to have a better colour, but the yield per acre is small, and the most economical conditions on the whole are maintained by those soils having from 7 to 8 per cent of clay and maintaining on an average about 7 or 8 per cent of water. As the soil becomes heavier in texture and the amount of water increases other grades and types of tobacco are produced . . . . As the relation of the physical properties of the soil is not thoroughly understood or practically recognised by the growers, a large amount of land is now cultivated in bright tobacco which is not suited to this plant and which does not produce a good grade. On the other hand, there are large areas not at present under cultivation which could be developed into very fine tobacco lands. The typical bright tobacco soil is of little value for any of the sample farm crops, although, when suitably located near transportation lines, it is admirably adapted to the production of early vegetables, watermelons, and sweet potatoes."

The manufacturing tobacco of Virginia and North Carolina is grown principally on the red clay soils located mainly on the gabbro, gneiss, and Lafayette clays. The subsoils of these areas contain from 30 to 50 per cent of clay, and although no observations have been made on the moisture content of these soils it is probable from observations made on adjacent soils that the mean water content is not far from 20 or 22 per cent. Since the introduction of White Burley tobacco the cultivation of the heavier types of tobacco has noticeably decreased in Virginia and North Carolina. "The industry is confined now principally to small areas along rivers, streams, or creaks, and upon recent deposits which cannot well be referred to any of the older geological formations and which can not well be examined without a detailed examination of the larger part of these States.

"The White Burley tobacco is confined to the well-marked type of soil of the Lower Silurian limestone in central and north central Kentucky, and the adjacent countries of Ohio. This embraces the blue grass region of Kentucky, and it is upon these fine, fertile, blue grass soils that the White Burley is grown." The soils are all heavy clays of a uniform deep red colour. The subsoils contain on an average about 30 per cent of clay. "The characteristic soil of the limestone area of Kentucky, adapted to the White Burley tobacco, as the result of several years' investigation, may be said to maintain on an average about 20 per cent, of water."

Export tobacco is grown in Kentucky and Tennessee on silty soils which are quite fertile in character These soils are derived chiefly from the St. Louis group of the subcarboniferous. They contain from 40 to 60 per cent. of silt and 22 to 23 per cent. of clay, and maintain an average water content of about 15 per cent.

"The object of the daily record of moisture in the soil is not only to determine the average amount soils contain, but to determine the

normal as well as the extreme variation . . . . It is possible from such records to show the character of a season. The methods of cultivation should have for their prime object the maintenance of the water supply above the line of drought, so that the growth of the plant shall receive no check. If this can not be done by the ordinary method of cultivation, irrigation must be resorted to upon such occasions, if the crop is to be maintained in its best condition."

THE COTTON-SEED OIL INDUSTRY IN GEORGIA.

By Joseph Jacobs.

In the present paper I shall endeavour to give some account of the cotton-seed oil industry, confining the statistical portion of the article mainly to my own State, Georgia, as this is one of the typical Southern States, and what is said in that connection is measurably true of the other Southern States of our Union; though the industry is by no means confined to the South.

While the Southern States of our country now principally supply the world with cotton, the cultivation of the plant is not at all confined to that section. Egypt, India, Australia, portions of China and many of the States of South America, as well as many of the islands of the seas, cultivate the variety of the Gossypium plant, known by the common English name "cotton."

In England there are now about twenty-five oil mills in operation, consuming principally black seed of the sea island plant transported in ships from Egypt, and the Hollanders are, perhaps, as largely engaged in the industry. The oil has been made in those countries for many years.

The superiority of the oil made in our Southern States is due partly to the fact that the seeds can be secured fresh from the fields, near the oil plants, whereas in England and Holland some months are often required to bring them over in sailing vessels. Besides, the English and Holland oil is not so clear as ours because the seed there treated is Egyptian or Indian, and is not decorticated, owing to the difficulty of picking it. Our cotton seed parts with its fibre more readily, and in every way yields better to treatment.

The first mill for the manufacture of the oil in this country was, perhaps, the one near Columbia, S. C., mention of which is found as early as 1826; though it was probably operated prior to that date. One of the mills in New Orleans before the war used a 35 horse-power steam press, producing 500 gallons of oil and 5 tons of oil cake a day. It required, as stated in the Southern Farmer and Planter, about 15 tons of cotton seed to produce this amount of oil and cake, or each ton yielded about 40 gallons of oil and 700 or 800 pounds of cake. In Memphis, Tenn., it was also made in large quantities. At this period we find the following published statement of the uses of the oil:—"This oil, refined by a secret process, is made of two qualities—the best use for illuminating and lubricating purposes and for currying leather, and the inferior for making soap equal to the palm soap. Cotton-seed cake was then considered of about equal value with flax-seed cake."

Prior to the war the cotton seeds were very little used as a stock food. Some farmers sparingly used them after boiling. They were abundantly applied as a manure, but only in their uncrushed condition. Browne,

in his "Field Book of Manures," says: "They abound in a mild oil, and are acconnted very nutritious after the oil is expressed, a bushel of seeds weighing 30 pounds, and yielding 2½ quarts of oil, and 12½ pounds of fine meal. The oil cake is very brittle, and breaks down more readily than linseed cake. The taste is not unpleasant, and it is stated it can be used with success in fattening stock."

In the Patent Office Reports, 1855, p 234, can be found "some chemical researches on the seed of the cotton plant," by Prof. Chas. T. Jackson. He refers to a patent taken out by D. W. Mesner. for separating the "hulls" from the cotton-seed. Analyses are given of the oil, the seed, the cake, etc. Professor Jackson employed ether to separate the fixed oil, and it was found that 100 pounds of the dried, pulverized seed gave 40 per cent. of pure fatty oil. The specific gravity of the oil is given as 0.923, which he states is the specific gravity of pure whale oil. He recommended its use for lubricating machinery, burning in lamps and for making soaps, and suggested its use as a substitute for olive oil, and use as a salad oil, it having no disagreeable odour or taste. On examining the cotton seed oil cake, he found that it possessed "a sweet and agreeable flavour, and was much more pure and clean than linseed oil cake." One hundred grains of the seed leave 60 grains of the oil cake. This cake examined for sugar was found to contain 1.1 grains, and for gum 35 grains. Iodine gave no proof of any starch in the cotton-seed, nor in the oil cake.

Since the war, the cotton-seed oil industry of the South has grown to immense proportions. The number of mills has increased from four in 1867 to over 300 at the present day. In 1872 the export of cotton oil only amounted to 4,900 barrels; in 1896 about 30,000 barrels, and the present products amounts to about 28,000,000 gallons per annum, worth about 30 cents. per gallon, causing the consumption of about 800,000 tons of cotton-seed. The product goes to nearly every European port, to Africa, Australia, India, the South American Republics, West Indies and Canary Islands and Japan. The Germans and Americans are said to prefer animal fats to vegetable oils, contrary to the taste of all other civilised people. The capacity of the various mills varies from a consumption of 250 tons a day by the larger mills to 15 tons by the smaller. The total capacity of the Georgia mills is about 2,000 tons a day, which, if run on full time, would consume more than the total seed product of that State, if all were available; but the fact is that much of the seed used by the Georgia mills is brought from Alabama, Mississippi, Florida and Carolina. The annual out-put of Georgia from the 200,000 tons of seed, is about 150,000 pounds of oil, 70,000 tons of meal, 8,000 bales in linters and 80,000 tons of hulls. The average value of the annual product is about $2,750,000.

I have thus endeavoured to give some of the facts connected with cotton-seed oil, its history and its quantity and production in the hope that our trade may find it a profitable product to deal in. I will now enumerate some of the uses to which it has been applied, hoping that they may suggest others even more in line with our especial interests.

The principal use to which it is put is for food purposes. The claim that it is more healthful than many animal fats has been largely responsible for its extensive adoption in this connection. Nearly seven-eights of the 38,000,000 gallons produced per annum probably find their way

into "refined lard" and salad and cooking oil. It is used for illuminating, in the manufacture of bolts and nuts; for all kinds of soap, bath, laundry and toilet soap. It is used as a substitute for olive oil as an emulsion in medicine; it has been prescribed as a substitute for cod-liver oil, and for olive oil in packing sardines, and in many other ways. It is said that its non-drying properties debar its use as a wood filler, or for stuffing hides in making morocco and other leathers. No treatment as has yet been discovered which will give it the "drying" properties of a good menstrum for paint. As a soap for woolen mills, it has been extensively adopted in America, England and Scotland.

As an illuminant, a writer claims that its place is midway between sperm and lard oil. It can be burned alone or mixed with petroleum. On the coast of Maine there are a number of establishments shipping "sardines" and "shadines," which are said to be cooked and then placed in boxes containing cotton-seed oil; and it has been charged that of the immense quantity of sardines exported from France and other European countries, largely more than three-fourths are now treated with cotton-seed oil instead of olive oil, as was formerly the exclusive practice. It has been suggested that the oil could be used in çandle-making and for steel tempering.—*(American Journal of Pharmacy.)*

USE OF GAS-LIME IN AGRICULTURE.

By Dr. J. A. Voelcker.*

Lime, it is well known, is largely employed in gas-works for the purpose of removing from crude coal gas, as it issues from the retorts, sulphuretted hydrogen and carbonic acid, which deteriorate its illuminating powers. After having served some time in the gas-purifiers and become more or less saturated with these and some other impurities, the lime is replaced by a fresh quantity of quick-lime and thrown aside for the use of the agriculturist. This gas-lime, or refuse lime from gas-works, is generally obtainable at a much more reasonable expense than most other forms in which lime is usually employed in agriculture, and constitutes a refuse material which, in many instances, has been applied with marked beneficial effects both to light and heavy land. The successful application of Gas-lime to the land, however, depends, like that of marl, chalk, and quicklime, upon a variety of conditions, some of which are peculiar to Gas-lime. These conditions we purpose briefly to examine, after having referred more particularly to the composition of gas-lime. Different samples, as may naturally be expected, vary to some extent in their chemical constitution, but the differences are not so great as to lead to the conclusion that whilst some samples are very efficacious as fertilising agents, others possess little or no manuring property. Judiciously used, all samples are economical means for increasing the productiveness of land adapted for its reception. In order to guard against disappointment, it may be well to state at once that gas-lime is not a universal manure like farmyard manure, benefiting more or less every description of crop on every variety of soil, nor that it is a concentrated fertiliser acting in a similar manner to Peruvian

* Journal of Gas Lighting, April, 1865.

guano, nitrate of soda, or bone manures. In point of fact, gas-lime exercises a most decidedly beneficial effect upon some soils but has no effect upon others; success in its application, therefore depends mainly upon the proper selection of the land upon which it is intended to be put. On this point we shall have, presently, to make some special remarks.

In the first place it will be desirable to inquire a little more closely into the

Chemical Constitution of Gas-lime.

As already stated, the sulphur compounds and carbonic acid in crude coal gas transform the slaked quicklime in the purifiers more or less into sulphuret of calcium, a combination of sulphur with calcium, the metallic base of lime, and into carbonate of lime. At the same time some tarry matter, a little ammonia, and other volatile substances pass into the gas-purifiers and are partially retained by the lime in a mechanical way. Fresh gas-lime has a bad smell, arising mainly from the sulphur compounds contained in it, and should not be put on the land in this condition, for the ameliorating influence of a copious supply of air is required to transform these injurious sulphur compounds into fertilising materials, the presence of which, in some respects, renders gas-lime exposed to air for some time superior to quicklime. The oxygen of the atmosphere completely destroys the bad smell of fresh gas-lime, by changing the sulphuret of calcium in it, first into sulphite, and finally into sulphate of lime, or gypsum. There is thus an essential difference between Gas-lime newly removed from the purifiers, and after it has been freely exposed to the atmosphere. In a fresh state it contains sulphur compounds, which give off sulphuretted hydrogen and are injurious to vegetable life; in the latter condition it contains gypsum, a well-known fertilising substance. The longer this refuse material is kept freely exposed to the air, the more completely these baneful changes are effected, and the more efficacious it becomes as a manure. In addition to the constituents already mentioned, Gas-lime contains a variable quantity of water, more or less unaltered quicklime, and all the impurities originally contained in the quicklime employed in the gas-works. In fresh Gas-lime the proportion of water varies usually from 30 to 40 per cent.; in old samples there is much less. The following analysis of a sample of Gas-lime, kept long enough to be used with safety as a manure, will show at a glance its complex character :—

Composition of Gas-lime (dried at 212° Fahr.)

Water of combination and a little organic matter	7.24
Oxides of iron and alumina, with traces of phosphoric acid	2.49
Sulphate of lime (gypsum)	4.64
Sulphite of lime	15.19
Carbonate of lime	49.40
Caustic lime	18.23
Magnesia and alkalies	2.53
Insoluble siliceous matter	0.28
	100.00

The efficacy of all fertilisers is due to the material substances which enter into their combination; and as many of the usual components of manures have a specific effect upon vegetation, it cannot be reasonably expected that Gas-lime, abounding in combinations of lime should produce the same results in the field as those which a phosphatic or ammoniacal manure is capable of producing.

A glance at the preceding analysis shows plainly that gas-lime acts as a fertiliser solely in virtue of the lime compounds which occur in it. Like quicklime, it discharges the four following important functions: (1) Gas-lime exercises a beneficial mechanical effect upon land, by rendering stiff, heavy clay land, more porous, friable, and consequently better adapted for cultivation, and by consolidating, on the other hand, light, sandy soils. (2) It supplies food to plants. All our cultivated plants on burning furnish ashes, containing a good deal of lime, which is essential to the healthy development of all vegetable produce. As plants have not the power of generating lime, it is clear either the soil upon which they are grown or the manure which is put upon it must contain a sufficient amount of this constituent, so necessary for the very existence of all plants. Gas-lime not only supplies lime to plants, but also sulphuric acid, a combination not present in any quantity in quicklime. For leguminous crops, such as Peas, or Beans, for Clover, and other crops specially benefited by sulphate of lime or gypsum, Gas-lime when obtainable, as is generally the case, at a trifling expense is certainly preferable to quicklime as a manure. (3) Gas-lime, in virtue of its alkaline properties, exercises a beneficial effect upon the organic matters in the soil. In this respect its action is similar to that of quicklime. Both facilitate the destruction of organic matters, the remains of previous crops, and their conversion into plant food. (4) Gas-lime, like quick-lime, has the power of unlocking, so to say, the naturally unavailable mineral stores of plant food in the soil. In many soils, but more especially in clay land, we find portions of granite and other minerals from which clay has been originally produced. These minerals are the chief sources from which the necessary amount of alkalies required by plants is furnished. But as their decomposition proceeds slowly, a long time must pass before potash and soda can be rendered soluble, or made available for the use of the plants. Gas-lime, like quicklime, materially hastens this decomposition, and thus produces an effect similar to that of a prolonged fallow.

Its Uses.

These remarks on the functions of gas-lime in relation to vegetable life at once point out the crops which are benefited by its applicati n, and in a special manner, the kind of land upon which it produces the most striking results.

The crops which are particularly benefited by Gas-lime are: Clover, Sainfoin, Lucerne, Peas, Beans, Vetches, and Turnips. It is also a most useful fertiliser for permanent pasture, especially if the land is naturally deficient in lime. On natural grasses the best farmyard manure often produces little improvement until a dressing of lime, marl or Gas-lime has been applied. The latter more particularly destroys the coarser

grasses and favours the growth of a sweeter and more nutritious herbage. Gas-lime also kills Moss, Heath, Feather Grass, and other plants characteristic of peaty land, and is, therefore, a valuable means for improving peaty or mossy meadows. For improvement of peat land, the liberal application of Gas-lime cannot be too highly recommended. On such land it is best to use Gas-lime in the form of a compost, which should be kept in a heap for a period of ten or twelve months, and turned once or twice before spreading. On land naturally deficient in lime, Turnips often refuse to grow, or, if they grow at all, produce but a scanty crop, which is moreover very liable to be attacked by a disease, known to practical farmers, as "finger and toe." A large dose of Gas-lime applied to the stubble land in the autumn, before it has been turned up by the plough, in many instances is an effectual cure for this disease. An interesting instance of the prevalence of "finger and toe" in a Turnip crop grown on a light, sandy soil, and the complete cure of this disease by a liberal application of gas-lime, was brought under my notice some years ago. On visiting the field where the Turnips were affected by wart-like excrescences, and forked and twisted into the most fantastical forms, I noticed a spot on which the roots were nearly all sound. On stooping down and examining the soil, I picked up some bits of a whitish-looking substance, which appeared to me like dried Gas-lime, and I learned afterwards that on this very spot a cart of Gas-lime had been unloaded the year before. The chemical examination of the soid on this field showed merely traces of lime, and, at my recommendation, the occupier applied a heavy dose of Gas-lime, which completely cured the evil.

With regard to the quantity of Gas-lime which ought to be put on the land, no general rule can be laid down, for the quantity should be regulated by the relative deficiency in calcareous constituents which different soils exhibit. Speaking generally however two tons per acre may be used with safety, and in many instances a heavier dressing will not be amiss. The proper time for application is autumn or during the winter months, when vegetation is at a standstill. On arable land gas-lime should be applied to the stubble, spread out evenly, and left exposed to the air before ploughing up for three or four weeks. On grass land it should be spread during the months of December or January, or at any rate before vegetation is making a fresh start.

In conclusion, I may observe that it is well to remember that gas-lime acts beneficially as a fertiliser mainly in virtue of its calcareous constituents, and therefore is most usefully supplied to land naturally deficient in lime. On land abounding in this substance it has little or no effect. Though by no means a substitute for farmyard manure, guano, and other concentrated artificial manures, Gas-lime judiciously used is unquestionably a valuable auxiliary manuring agent which frequently can be used with greater economy than quicklime or marl.

FERNS : SYNOPTICAL LIST—LVI.

Synoptical List, with descriptions, of the Ferns and Fern-Allies of Jamaica. By G. S. JENMAN, *Superintendent, Botanical Garden, Demerara.*

Order IV.—*Selaginellaceæ.*

Sporangia of two kinds, larger and smaller; the former (macrosporangia) containing macrospores; the latter (microsporangia) containing microspores; borne separately in the axils of normal or modified leaves, in which they are single, and free or partially embedded; the macrosporangia being calcareous-white and inferior in situation to the microsporangia.

This order consists of two very dissimilar genera if only the physiognomy or conformation of the respective members be regarded. They are associated however by the character which they possess in common, of the sporangia and spores being of two kinds, one larger than the other, generally considerably larger; each kind of the spores possessing separate sexual potentiality, generation resulting from the interaction of the contents of the cells that are produced on their germination; if this union is not affected the antecedent germs perish.

Fructification in terminal spikes in the axils of imbricating keeled bracts; leaves usually dimorphons.

1. Selaginella.

Fructification embraced in the clasping case of the normal leaves; the plants rosette-like in form.

2. Isoëtes.

Genus I. *Selaginella,* Beauv.

Sporangia bivalved, uniform, orbicular, or subglobose, borne in modified 4-gonal spikes, at the end of the branches; macrosporangia inferior, usually few, containing few large white macrospores; microsporangia superior, usually numerous, containing multitudinous minute microspores; leaves small or minute, generally of two kinds—rarely of one-major and minor, each kind bi-serial, imbricating or slightly apart, the larger series lateral and spreading from the axis obliquely or horizontally, the smaller intermediary, more or less in a line with and dorsal on the axis and appressed thereto; fronds generally pinnately or irregularly divided, rarely simple, often decompound; more or less copiously leafy throughout; prostrate, sub-erect, erect or scandent.

Selaginellas differ from their allies the club-mosses by possessing two kinds of sporangia and spores, the generally distichous arrangement of the leaves, which gives the stems a flattened appearance, their more or less prostrate or subscandent habit of growth, their uniformly communal association and, as a rule, terrestrial location. Three or four Lycopodia have a somewhat similar arrangement of their leaves, and a considerable number are terrestrial, and some too are communal, but among the selaginellas these are nearly constant characteristics. In a few species, none of which is native within the limits of this flora, the leaves are all of one kind and multifarious, the stems being consequently convolute, as is the rule in the Lycopodia. In nearly all the species there is some variation of shape in the fronds, and in many this is considerable.

Bracts of the fruit-spikes all of one kind.
Fronds prostrate or sub-erect, not flagelliform at the apex.
Rachises not exceeding 1–1¼ li. wide across, the leaves included.
1. S. caribense.
2. S. porelloides.
3. S. denudata.
4. S. confusa.
Rachises not exceeding 1½–2 li. w. across, the leaves included.
5. S. albonitens.
6. S. serpens.
7. S. didymostachya.
Fronds prostrate or suberect, flagelliform at the apex.
8. S. patula.
9. S. setigera.
10. S. stolonifera.
Fronds erect.
11. S. cuspidata.

1. *S. caribensis*, Jenm.—Fronds prostrate, very delicate, 1–2 in. l., usually leafy to the base, the shorter ones quite simple, the longer with short alternate mostly distant branches which are 1–6 li. l., ¾–1 li. w. over the leaves; leaves contiguous, apart, or the lower ones subdistant, about ½ li. l. or less and rather less w. point rounded or subacute, base subcordate, the upper auricled side ciliate and deeper than the rather contracted lower; minor leaves minute, apart, aristato-acuminate, subcordate, the outer side longer than the inner, the margins slightly ciliate, spikes about a li. l. the bracts not distinctly keeled, ciliate-marginal, lax or spreading and revealing the sporangia. Baker, Fern Al. p. 68.

Rare in forests at 5000–7000 ft. alt. on trees and decaying logs. Intermediate between *confusa* and *rotundifolia*, much weaker and more delicate than the former, and not so lax and delicate as the latter. The leaves only imbricate at the tips of the short branches, elsewhere they are more or less apart, increasingly so downwards. Both the main rachis and branches are the same width over the leaves. The fertile bracts are rather broader, but otherwise conform with the intermediary leaves. The sporangia are very few to a spike, only 2–3 or 4 in my specimens.

2. *S. porelloides*, Spring—Fronds rooted at the base, variable in outline-subdeltoid or irregular, bright or dark green, membranous, freely but openly branched, twice-pinnate, the branches about 1 li. w. over the leaves; rachises very slender and angular; major leaves apart, oblique, ovate-oblong, ½ li. l. less w. barely pointed, inequilateral, the rounded and broader superior base imbricating on the rachis, the margins faintly spinulose-ciliate, minor leaves apart, ovate-cuspidate, the margins ciliate, the outer side extending beyond the rachis; spikes copious, 2–5 li. l.; outer bracts sharply keeled, cuspidate, inferior open.—Fée, Fil. Ant. t. 34. fig. 3. Baker, Fern Al. p. 85.

Forests at 6,000 ft. alt. In its leaves this resembles *confusa* but it is quite differently branched, and is of a much broader and different shape.

3. *S. denudata*, Spring.—Fronds 6 in. l. irregularly branched, the branches flaccid and laxly sparingly again branched: major leaves apart on the rachises, but crowded on the outer part of the final branches, ovate, subobtuse, 1 li. l. horizontal, subequilateral, the base equally

cordate, firm in texture; minor leaves but little smaller, ovate, acute; spikes short, 4-stichous, square; bracts ovate-lanceolate, strongly keeled, Bak. Fern. Al. p. 55. *Lycopodium* Willd. Jamaica; collected by Swartz. This I have not seen and the description is made up from Mr. Baker's, in his synopsis of the genus, which again is made from Spring's Monograph ii. 84. Grisebach supposes it to be a form of *confusa* devoid of marginal bristles to the leaves, but in every species almost these bristles are a varying character, and their absence, without other characters, would not constitute a specific difference.

4. *S. confusa*, Spring—Fronds 3–4 or 5 in. l $\frac{3}{4}$–$1\frac{1}{2}$ in. w. pale green, composed of the central axis and few or several distant alternate simple or again branched branches, which are $\frac{1}{4}$–1 in. l., and 1 li. w. over the leaves, below which is a slender decrescent stem 1–3 in. l. very laxly clothed downwards with decrescent minute leaves; major leaves lax, spreading with usually half or fully their own width between them, flat, ovate rather pointed subcordate and ciliate on the rounded wider upper base, $\frac{3}{4}$ li. l. rather less w., minor leaves ovate, aristate-pointed, $\frac{1}{2}$ li. l., the margin ciliate, reaching from one to the other alternately, but not imbricating; spikes 1–3 or 4 li. l, 4-stichous; bracts keeled loose, ciliate-margined; sporangia smaller. Baker, Fern Al. p. 85.

a var. *densa* Jenm. Fronds shorter, all parts more compact, lateral leaves rather narrower both kinds closely imbricated.

Frequent in forests at 5,000–7,000 ft. altitude on trees and rocks. A slender weakly species of uniform width in all its parts, rather lax in leafage and variable, but still well marked, in form. There is generally a slender threadlike stem bearing root-fibres at the base, the small scattered leaves on which increase in size upwards towards the branches. In branching it is variable. In some of the weaker states, though regularly pinnate, the branches run together at the top, while in others they spread laterally as regularly as in *serpens*. Perhaps these are distinct varieties, as the leaves in the former are much smaller and the general habit weaker. The spikes are often flattened in dried specimens though strictly 4-stichous in life. Var *a* is much shorter, very much denser in habit and a dark green. It is my n. 30 of 1876, in part in Herb. Kew.

S. rotundifolia, Spring Fée. Fil. Ant. t. 34 is likely an inhabitant of Jamaica, but has not yet been gathered there. It grows on stems of trees and on logs.

5. *S. albonitens*, Spring.—Stems short and threadlike if any clear of the leafy base of the fronds; fronds delicate, pale or dark green, spreading, from 1 in. each way to, rarely, 2 or 3 in., twice or thrice pinnate, the lateral branches extending generally nearly or quite as much as the central making the outline more or less flabellate; 1–$1\frac{1}{2}$ or rarely 2 li. w. over the leaves; leaves with a short space between them half or fully their own width; the major one spreading, oblong, obtuse or rounded at the end, $\frac{3}{4}$–1 li. l., barely $\frac{1}{2}$ li b.; minor very small, ovate-lanceolate, with a long spinescent somewhat cuspidate point; spikes 3–5 li. l., hardly $\frac{1}{2}$ li. w., 4-stichous; bracts ultimately loose; sporangia very minute.—Baker, Fern Al. p. 72.

Infrequent on open banks at 3,000–5,000 ft. altitude. A very small species, generally not much over an inch high, consisting of a few irregular branches, nearly 2 li. w., with spoke-like, relatively long,

fertile spikes. Its distinguishing features are the spreading habit of growth, oblong lateral leaves, that are not at all pointed, long-pointed intermediary ones, which under a strong lens are faintly denticulate, and long fertile spikes. The latter, as in *confusa*, are compressed in dry specimens.

6. *S. serpens*, Spring.–Fronds prostrate throughout, ½–1 ft. l. 1–4 in. w., pinnately branched from the base upwards, tri-quadripinnate, the leaves unmodified both at base and apex, varying in colour at different times, elastical-membranous in texture, pinnary branches 1–1½ li. w. over the leaves, variable in length and generally irregular or unequal in the same frond, 1–4 in. l.; secondary ¼–½ in. l.; tertiary (if present) only rudimentary, but fertile; leaves slightly imbricating generally, but often not, or barely, on the primary rachis; major subovate, spreading, nearly equilateral, cordate, with rounded auricles at the base, the point blunt or rounded, ¾–1 li. l., and as wide, the inferior basal margin ciliate; minor leaves attached laterally near the base, ovate, pointed but not spinulose, outer margin spinulose—ciliate all round, ½ li. l.; spikes 1–6 li. l., ½ li. w. 4-stichous, square but loose; bracts sharply keeled.—Baker, Fern Al. p. 46

Very abundant on open banks and rocks, spreading in large patches, which completely conceal the surface, the fronds quite flat, with hair-like roots from the joints of the rachises on the underside; chiefly at low altitudes and among the lower hills. The colour changes during the day and varies from a very pale green to purplish-brown in different parts. The texture is rather elastic, and contracts somewhat when dry. The branches are 1½–2 li. w. The lateral attachment of the intermediary leaves, which makes them ear-shaped, the sharp rib of the rachis showing between the two rows, are reliable and certain characters for determining the species.

7. *S. didymostachya*. Spring.—Fronds stiff, light wiry, or dark green, ½–1 ft. or more l repeatedly and much branched from the base upwards, prostrate, with long filiform stramineous roots descending from the joints beneath; the branches 1–2 li. w. over the leaves; rachises throughout flexuose, glossy stramineous, stiff, and wiry, but not rigid, the leaves conform, but rather more lax than those of the branches; major leaves ovate-oblong, inequilateral, rounded but with an indistinct point at the apex, the joint at the base raised, 1 li. l. ¾ li. w., not imbricating, or only slightly so in the final branchlets, the margins usually naked; minor leaves ascending in the line of the rachis, cuspidate, subkeeled in the outer branches, faintly spinulose-ciliate, ½ li. l. or less, little imbricating or not; spikes 2–4 li. l. ½ li. b., square, bracts appressed or loose, keeled. Baker, Fern Al. p. 55.

a. var. *integerrima*, Fée. Fil Ant. t. 34, fig 4.—Fronds smaller and more compact, with narrower parts.

b. var. *densa*, Jenm.—Habit very dense, final branches very numerous, lying close together.

Abundant in mountain forests, principally in the middle region, from 2,000–4,000 ft. alt., covering the ground, to which it is lightly attached by the long stilt-like stramineous glossy descending roots. It is a well-marked species characterised by the wiry roots, its usually lax freely branched habit, strong, stiff, and constantly zig-zag rachises, which are quite cylindric, and raised joints of the leaves.

8. *S. patula*, Spring.—Fronds light green, often silvery beneath, membranous, quite prostrate, triquadripinnate, 4–6 or 12 in. l. 1–3 or 4 in. b., branched and often reduced from the base upwards, rachis distinct throughout, very slender, and extended beyond the upper decrescent branches in a threadlike tail, quite laxly clothed throughout with minute leaves of one kind only, which are not spinulose-pointed, the outer margin at the base spinulose-ciliate; primary branches spreading, about 1 li. w. over the leaves, the inferior ones with a terminal tail like that of the primary rachis; leaves imbricated, the major spreading, oblong, the point acute but not pungent, outer margin ciliate, $\frac{3}{4}$ li. l. $\frac{1}{4}$–$\frac{1}{3}$rd li. w.; minor leaves ovate, spinulose-pointed, spinulose-ciliate on the outer margin, $\frac{1}{3}$rd–$\frac{1}{2}$ li. l.; spikes short, $\frac{3}{4}$ li. w., 4-stichous; bracts loose, ciliate-edged or not; sporangia minute.—Baker, Fern. Al. p. 46.

Infrequent on open rocks and banks at various altitudes up to 3,000 or 4,000 ft. This like *setigera*, is marked by the slender elongated rachis, clothed above and below the frond portion proper with small difform leaves of one kind, that run through the frond, extending tail-like at the top, and also in the principal branches. The contrast is the greater owing to the leaves of the intermediate parts being close and imbricated. Though distinctly 4-stichous, the spikes are so short and the bracts so lax that they are not very distinctly angular. The leaves of the stem and rachis resemble in character the lateral leaves of the branchlets, but are reduced in size and more ovate in shape.

9. *S. setigera*, Jenm.—Stems firm, slender, suberect, clothed with firmly appressed minute leaves throughout, ribbed when dry, and stramineous; fronds compact or lax, somewhat variable in shape, ovate, deltoid or lanceolate, extending into a long slender radicant flagelliform tail, tripinnate, the primary branches sometimes extended like the main axis of the frond and radicant, dark green, firm; major leaves on the main axis contiguous or close, obliquely and flatly spreading, sub cordate, ovate-deltoid, hardly acute, $\frac{1}{2}$–$\frac{3}{4}$ li. l. less w., the base ciliate: those of the outer branches imbricating, oblong or linear-oblong, obliquely acute-pointed; the branches 1–1$\frac{1}{2}$ li. w., over the leaves, minor leaves ascending, close or contiguous, ovate, spinulose-pointed, inequilateral, the base cordate, ciliate or spinulose-edged all round, about $\frac{1}{4}$ li. l. and extending to the end of the thread-like tail which is devoid of major leaves; spikes 1–2 li. l., the shorter ones lax, with open convex, keeled acuminate bracts, pressed back by the large sporangia. Baker, Fern Al. p. 75.

By its habit of extending and rooting at the end of the tail, and there producing new-growth, this resembles in hab t *patula* as before said, but is a larger and darker coloured plant. The slender unbranched stem at the base is 2–6 in. l.; the frond 3–6 in. and the extended outer part from a few inches to a span or more. Sometimes short alternate sub-distant branches extend upwards on the prolonged outer part, thus making the frond a foot or less long.

10. *S. stolonifera* Spring.—Fronds trailing, a foot or more l., extended into a whip-like tail at the end, freely decompound; rachises angled, jointed at the nodes; branches short, compound; major leaves apart on the rachises, close in the outer parts, oblique, oblong or oblong-lanceolate, acute, sub-cordate, nearly equilateral but laterally in-

serted, the superior base more rounded and ciliate, not imbricated on the rachis, firm in substance and stiffish, 1–1½ li. l.; minor leaves ½ to ⅓ as long as the major, sharply pointed; spikes ¼–½ in. l., tetragonal, ½ li. w., bracts imbricating, keeled, acute.—Baker, Fern Al. p. 61. *Lycopodium*, Swartz.

Gathered by Swartz in Jamaica, but not since his day.

11. *S. cuspidata*, Link.—Stems, erect, rigid, terete, ½–1 ft. l., 1 li. thick, sometimes branched, generally with few or several abortive spurlike buds 1–2 li. l along the sides, clothed throughout with imbricating ciliate-edged, clasping leaves, which are 3–4 serial and all of one kind; fronds erect, stiff, light green, subovate or ovate-deltoid, usually broadest at the base and narrowed upwards, 3–5 in. each w., repeatedly pinnate; the branches very dense and close and ½–¾ li. w. over the leaves; major leaves very densely imbricating, ovate-acuminate, ¾ li. l. ½–¾ li. w., the inner (or upper) margin ciliate; minor leaves about half the size, spinulose-pointed, faintly denticulate towards the point, inequilateral, the double series imbricating one with another; spikes very numerous, occupying all the branches, densely 4-stichous, ¼–¾ in. l. ½ li. w., bracts faintly ciliate on the margins; sporangia very minute.—Baker, Fern. Al. p. 89.

Infreqnent on open banks and waysides in the Port Royal mountains at 2,000–4,000 ft., altitude, having stiff,erect stems, with a spreading usually deltoid frond at the top, very dense in all its parts. The pinnae more or less over-lap, and the branchlets are rather concave on the upperside and convex or almost keeled on the under. Throughout the leaves are so very densely imbricated that no part of the stems or rachises is visible. The spikes are long, square-edged, the sides rather concave.

Genus II. *Isoëtes*, Linn.

Sporangia contained in the axils of the leaves, partly immersed in the interior of the base, the macrosporangia in the inferior and microsporangia in the superior ones. Microspores spherical; microspores 3-gonal; leaves herbaceous, from a few inches to a foot or more high, springing in a dense rosette from a thickened corm-like rootstock, acaulescent, the expanded base clasping, tapering thence upwards to the acuminate, often convolute point. These, the Quillworts of Britain, are herbaceous bog or aquatic plants, with numerous leaves, appressed together at their expanded clasping bases, from whence they taper rapidly to the much reduced point, the height varying with the different species, forming a dense upright cluster or open rosette. The sporangia are concealed in the clasping bases, and must be sought for by removing the leaves. I have seen no Jamaica species, but it is possible the genus may be represented in the higher regions as it is in the countries around for to the inexperienced the plant might be passed as small tufts or aquatic ridge. The Cuban species in *I. cubana*, Englm., which has a trilobed rootstock, few or numerous thinly grass-like, acuminate, filiform leaves, reaching from a few to several in. l., the base delated and clasping with relatively small sporangia macrospores and microspores. Baker, Fern Al. p. 133.

ORDER V. *Marsileaceæ.*

Capsules scattered or serial on the root-stock or the base of the petioles, globose or ovate-oblong, coriaceous, 2–4 valved, dehiscent, sporangia membranous, indehiscent; spores of two kinds, macrospores and microspores. Rootstock free-creeping, slender, vernation circinate. Leaves linear-filiform, or 4-foliate, at the summit of slender erect petioles.

This order like the preceding contains two dissimilar genera. One, Pilularia, is confined to temperate regions, the other, Marsilea, to the warm temperate and tropical, and is here represented.

Genus I. *Marsilea*, Linn.

Capsules stipitate, 1–2 li. diameter, serial on the rootstock or the base of the petioles, coriaceous, dehiscent, bivalved, containing numerous sacklike membranous transverse sporangia which contain both macrospores and microspores; rootstock creeping; leaves 4-foliate, at the summit of slender erect petioles.

These are small perennial plants that grow gregariously in still fresh water, floating on the surface, and are distributed through the tropical and the warm and cool temperate regions of the world. About forty or fifty species are known. The capsules are small pea—or bean—like bodies, leathery in substance, containing a series of pale thinly-membranous transverse sack-like cells, in which the spores stand lengthwise, 3–serial, the larger oblong, (macrospores) forming one series, the central, and the smaller (microspores) two. The former are several times larger than the latter, which, till removed, they quite conceal.

1. *M. polycarpa*, Hook and Grev.—Rootstock thick as small cord, free-creeping, naked, with filiform long descending roots and scattered ascending petioles, that are slender, 4–8 in. l. naked; leaves 4-foliate, terminal on the summit of the petiole; leaflets wedge-shaped, the outer edge rounded, at first folded together, spreading subsequently; $\frac{1}{4}$–$1\frac{1}{4}$ in. in diameter each way, sessile, membranous, herbaceous; venation reticulated, fine, with no primary ribs, anastomosing, forming narrow elongated linear meshes; sporangia subglobose $1\frac{1}{2}$ li. diameter, serial on the lower part of the stipes above a vacant space at the base, shortly stipitate, few or many, densely tomentose, but becoming eventually naked. — Icon. Fil. t. 160. Baker, Fern Al. p. 139. *M. brasiliensis*, Mett.

Common in ponds and trenches, lagoons, and other still water, covering where found, the surface densely, with oxalis, or clover like foliage, and spreading over large areas. The Jamaica plant, gathered by Purdie, Feb. 1844, in ponds at Hodge's Penn. St. Elizabeth, is *M. subangulata*, A. Br., and regarded by Mr. Baker as a variety of *polycarpa*. It is much smaller, with densely tomentose rootstocks and buds, fewer and smaller sub-angular very tomentose capsules. A specimen gathered by Miss Taylor at the Cedars, St. Catherine, is larger but not in fruit. Another small species with tomentose capsules, *M. Berteroi*, A. Br. is found in St. Domingo. The general range is Cuba southward to Brasil.

ADDITIONS AND CONTRIBUTIONS.

LIBRARY.

Botanical Magazine. Oct. [Purchased.]
Chemist & Druggist. Oct. 8, 15. [Editor.]
Garden. Oct. 8, 15. [Purchased.]
Nature. Oct. 6, 13. [Purchased.]
Pharmaceutical Journal. Oct. 8, 15.
Produce World. Oct. [Editor.]
Sugar. Oct. [Editor.]
W. I. & Com. Advertiser. Oct. [Editor.]
Sucrerie Indigène et Coloniale. Oct. 11. [Editor.]
Tropenpflanzer. Oct. [Editor.]
Bulletin de L'Herbier Boissier. Oct. [Conservateur.]
Agricultural Ledger. 1893, 2-6. (Calcutta). [Lieut. Governor, Bengal.]
Pro. Agri.-Horti. Society, Madras. June. [Secy.)
R. Bot. Gardens, Ceylon. Circular 8. Aug. 20. [Director].
Times of Ceylon. Sept. 21, 29. [Editor.]
Agricultural Gazette, N. S. Wales. August. [Dept. of Agr.]
Contributious to the Flora of New S. Wales. By J. H. Maiden. [Author.]
Sugar Journal, Queensland. Sept. [Editor.]
Agr. Journal, Cape of Good Hope. Sept. [Agr. Dept.]
Agri. Gazette, Barbados. July—Oct. [Editor.]
Bulletin Bot. Sta. Barbados. 9. [Superintendent.]
Journ. Royal Agri. & Com. Soc. British Guiana. [Editor.]
Proc. Agricultural Society, Trinidad. Sept. 30. [Secretary.]
Publications of the following Agri. Experiment Stations U.S.A. [Directors.]
Arizona, 29. Arkansas, 53. Iowa 37, 38, 39. Ohio, 84, 90, 91, 92, 93.
Botanical Gazette. Oct. [Editor.]
Photogravures of Amer. Fungi, 25, 26 Oct. By C. G. Lloyd. [Author.]
Contributions from the Bot. Dept. Iowa Coll. Agr. [Authors.]
Comparative Phenological Notes. By H. G. Irish. [Author]
Seeds and Tests of Some Cruciferae. By L. H. Pammel. [Author.]
Torrey Botanical Club Bulletin. Oct. [Editor.]
Ontario Agr. Coll. and Exp. Farm. Bulletin 109. Sept. [Dept. Agr.]

SEEDS.

From Royal Botanic Gardens, Demerara.
Castilloa elastica.
Manihot Glaziovii.

From G. French Esq., Melbourne.
Atriplex semibaccatum
Cassia floribunda
Pittosporum crassifolium
Eucalyptus citriodora
E. rudis
Sterculia acerifolia
S. popylneum
Acacia acinacea
A. elata
A. lophantha
Cordyline nutans
Hardenbergia monophylla

From H. Dixson, Esq., Sydney.
Xanthorrhoea sp.

From Stirling Fisher, Esq., Mahogany Hall, Jamaica.
Bread Nut (Brosimum alicastrum)

From James Gall, Esq., Kingston, Jamaica
Laburnum

HERBARIUM.

From D. Trench, Esq., Hazelymph, Jamaica.
Blind Eye leaves

[Issued 26th November, 1898.]

New Series.] DECEMBER, 1898. Vol. V. Part 12.

BULLETIN

OF THE

BOTANICAL DEPARTMENT, JAMAICA.

EDITED BY

WILLIAM FAWCETT, B.Sc., F.L.S.

Director of Public Gardens and Plantations.

CONTENTS:

PRICE–Threepence.

A Copy will be supplied free to any Resident in Jamaica, who will send Name and Address to the Director of Public Gardens and Plantations, Kingston P.O.

KINGSTON, JAMAICA:

GOVERNMENT PRINTING OFFICE, 79 DUKE STREET.

1899.

JAMAICA.

BULLETIN

OF THE

BOTANICAL DEPARTMENT.

New Series.] DECEMBER, 1898. Vol. V. Part 12

CITRATE OF LIME AND CONCENTRATED LEMON AND LIME JUICE.

By FRANCIS WATTS, Government Chemist.

Some attention has lately been directed to citrate of lime and it has been suggested that this should form an article of export from Jamaica.

It is well known that lemon and lime juice constitute the raw mateial from which citric acid is manufactured; these juices usually contain from 10 to 15 ounces of citric acid per gallon, sometimes exceeding these limits from exceptional causes; if exported in this condition the cost for freight and packages would be exceedingly high, hence efforts are made to obtain the citric acid in a more concentrated form. Three methods of doing this have been suggested, concentration of the juice by boiling, the preparation of citrate of lime, and finally the preparation of citric acid in the country where the fruit is grown. The first two have for their object merely the production of raw material for the manufacturer iu a concentrated form.

The preparation of concentrated lemon and lime juice is a very simple matter: The juice is passed through strainers to remove seeds and floating impurities, and is then boiled down to a proper degree of concentration, in copper or iron vessels, over open fires much in the same way that cane juice is evaporated in the old fashioned muscovado process of sugar making. When several evaporating vessels are placed in a series over the same fire, forming a battery, it is important to notice that the vessel or pan in which the juice is brought to its highest state of concentration is furthest from the fire while that containing the fresh juice is over the fire itself; thus a battery for lime juice is hung in the reverse way to a sugar battery.

In concentrating lemon juice efforts are made to obtain a product containing 64 ounces of citric acid per gallon, this being regarded as the standard strength, and a pipe of 108 gallons being regarded as a standard package; hence when the market price of concentrated juice is

quoted at so much per pipe these standard quantities are assumed. In reality these quotations refer to an arbitrary quantity of 432 pounds of citric acid. In the production of concentrated lime juice in the West Indies it has been the practice to carry the concentration to a higher degree than this, so that concentrated lime juice usually contains upwards of 96 ounces per gallon; a good rule in practice is to endeavour to produce concentrated juice which will have a uniform specific gravity of about 1·300. In dealing with lime and lemon juices a particular form of hydrometer, known as a citrometer is frequently made use of, though its use is less common than formerly. Knowledge of the origin of its scale and the meaning of its indications appears to have been lost; from experiments which I made some years ago I came to the conclusion that the instrument is so constructed that when placed in hot (boiling) lemon juice it will indicate the same degree as a Twaddel's hydrometer will show when floating in the same juice in the cold. It is thus a useful instrument in the hands of the man in charge of the concentrating pans, for he can from time to time test the juice rapidly, in a hot condition, and arrest the boiling when the citrometer indicates the same degree which on a Twaddel's instrument will correspond to the specific gravity 1·300; this of course is 60°. Hence the rule for concentrating becomes:—Carry on the concentration until the citrometer, when immersed in the juice at the boiling temperature, shows a density of 60°. The product thus obtained is a dark, nearly black, thick liquid.

It is often urged that there is very considerable loss of citric acid when juice is treated in this manner. My own experiments lead me to suppose that when juice of good quality is treated, the loss is about 7 to 8 per cent. of the original acid; when juice of poor quality is dealt with, this loss may reach 10 or 12 per cent. probably owing to the greater length of time required to concentrate the poorer juice to the required density. If concentration is carried beyond the point indicated the loss rapidly increases. The concentration here recommended is that which I believe to afford the maximum concentration with the minimum loss of acid.

The concentrated juice should be thoroughly cooled before being placed in casks or the casks will leak: indeed leakage from the casks is one of the most serious troubles which the maker of concentrated juice has to contend with. Casks containing 54 gallons are usually employed.

The suggestion that the concentration of the juice should be conducted in steam heated evaporators naturally occurs: it is open to question whether these would offer such advantages as would compensate for the increased complication and expense of the plant: the loss of acid from over heating might be reduced somewhat. Only when the manufacture is conducted on a very large scale will the question of the use of steam evaporators arise, and here it might be desirable to conduct the first part of the evaporation over an open fire, while finishing the evaporation of the thick juice in steam heated pans.

The process as now conducted is a simple one, its defects are that it necessitates the employment of a considerable quantity of fuel, it involves the loss of about 8 per cent. of acid, the product is dark in colour, is liable to leak from the casks and requires expensive packages.

In order to minimise these defects it has been proposed to conduct the first part of the manufacture of citric acid on the spot, and produce citrate of lime. This idea has been afloat for upwards of thirty years: in the last few years it appears to have been acted upon with some degree of success: in fact it is stated that this article has entirely taken the place of shipments of concentrated lemon juice from Palermo.

I am unable to ascertain the actual quantities imported into England and other European countries, but Messrs. Gillespie Bros. & Co. of New York, who have made enquiries on the subject, inform me that the imports into the United States for the past few years have been as follows:—

Years.	Quantities.	Values.	Value per unit of quantity.
	Lbs.	$.	
1887	42,558	6,004	.14
1889	47,890	8,569	.18
1891	28,358	4,337	.15
1892	220,468	30.459	.14
1893	629,739	75,271	.12
1894	443,891	52,137	.12
1895	608,214	59,458	.10
1896	668,106	66,388	.097
1897	496,291	42,090	.085
1898	1,026,467	84,789	.082

Up to the present this appears to have been entirely produced in Italy or Sicily, none having been imported from the West Indies.

The preparation of citrate of lime is the first step in the manufacture of citric acid from lemon or lime juice. We are well aware that when the juice of the sugar cane is concentrated to a sufficient degree, the active principle, cane sugar, separates out in the form of crystals; the active principle of lemon or lime juice, citric acid. will not separate in a crystaline form when the juice is simply concentrated, owing to the presence in the juice of a large quantity of gummy or pectic impurities. In order to overcome this difficulty the citric acid is brought into combination with lime, the citrate of lime thus formed being insoluble in water can be separated from the gummy matters which remain dissolved. In order to effect this the juice is neutralised with chalk, the resulting citrate of lime is allowed to subside and finally separated by straining by means of linen or canvas. The resulting citrate may now be dried for shipment or be treated with sulphuric acid for the manufacture of citric acid.

Simple as the above process appears, there are many practical difficulties, particularly in the preparation of the dried citrate for export.

In the first place the chalk employed must be of very fine quality, free from magnesium salts and from more than a trace of iron, alumina, and phosphates. Either of these impurities exercises a prejudicial action at one or other stage of the manufacturing process. Again the chalk must be of such a quality that it can be readily mixed into a cream with water, it must be free from lumps. In order to obtain chalk of proper quality English or French levigated whiting was for a long time imported into Italy and Sicily for the preparation of citrate

of lime : now, however I believe suitable forms have been found closer at hand. To get over the difficulty of obtaining chalk possessing the necessary fine powdery character and the requisite purity, the use of slaked lime suggests itself, this latter substance occurs in the form of a fine powder, easily mixed with water and can be obtained in a state of great purity; in default of other pure sources of supply, coral may be used, this will yield lime containing a negligable amount of impurity. Analyses af several kinds of coral showed Carbonate of lime 95 37 to 98·07 per cent. Phosphate of lime ·32 to ·84 per cent., Organic matter 1·93 to 3·79 per cent.

Should slaked lime be used, care must be taken not to neutralise the juice completely or impurities will be precipitated with the citrate, and these impurities will interfere with the subsequent manipulation and the production of citric acid : where slaked lime has to be employed it would appear desirable to complete the neutralisation with chalk, using the lime only for the neutralisation of the greater part of the acid.

In producing citrate of lime, the lime or lemon juice is placed in a suitable mixing vessel, large enough to prevent loss from overflow from the foaming effervescence which takes place when chalk is added. A sufficient quantity of chalk is made into a cream with water and the mixture poured cautiously into the juice with constant stirring, proceeding cautiously as the acid is neutralised. There is some difficulty in ascertaining when the exact point of neutralisation is arrived at, for in the presence of certain impurities, notably phosphate of iron, the juice remains acid although an excess of chalk may have been added. To ascertain how much chalk is to be used it is best to proceed as follows, —when the greater part of the chalk has been added, the mixture is well stirred and the effervescence is allowed to subside, a small quantity is then taken out and tested by the addition of a little of the mixture of chalk and water; if this produces an effervescense more chalk must be added to the main quantity, proceeding cautiously and testing at intervals, until no effervescence is produced. A further test is now made,—a little of the mixture is withdrawn and heated, as soon as bubbles of gas cease to be given off, a few drops of acid, fresh lime juice will answer, are added, this will produce a slight effervesence if chalk has been added in right amount, and a brisk effervesence if too much has been used. In the latter case, more juice must be added to the mixture and the process of testing repeated.

Having added the correct quantity of chalk it is desirable to heat the mixture for a few minutes nearly to boiling point, actual boiling is not necessary, this causes the citrate of lime to become crystalline and to subside rapidly in a condition in which it is easily manipulated.

In the earlier attempts to prepare this substance the heating at this stage was omitted, the juice was neutralised and the citrate of lime was separated from the cold liquor and dried. In consequence of this method of working the finished citrate contained many impurities, it dried in the form of hard lumps or of a powder full of hard knots so that grinding had to be suggested, it was difficult to powder and when thrown into water it was wetted with difficulty so that the manufacturer had difficulty in acting upon it with sulphuric acid when converting it into citric acid. Owing to the presence of impurities the citrate often

became dark on drying, and yielded a dark coloured liquor in the citric acid factory, a liquor which filtered with difficulty. All these features were very objectionable to the citric acid maker, and led him to prefer concentrated juice to citrate of lime as his raw material. Heating, by rendering the citrate crystalline, permits of its purification, many of the impurities are removed with the water and can be easily washed away. It seems very important that heat should be used at this stage; it is probably due to its omission that the earlier experimenters with citrate of lime encountered so many difficulties.

As soon as the citrate is seen to become crystalline and subside rapidly the heating is stopped, the citrate quickly settles leaving a clear yellow liquid above, this liquid is poured off or syphoned off, as much water being removed as possible. Washing the citrate a few times with hot water is advantageous, this removes the gummy matters which cause the citrate to cake into lumps in drying and which may give rise to darkening in colour and the subsequent production of dark and troublesome citric liquors in the manufacture of acid. The earlier samples of citrate contained so much impurity and were so difficult to manipulate that they found little favour with manufacturers.

The method of dealing with the citrate at the next stage of the process will depend entirely upon the scale upon which the manufacture is conducted; when the operation is conducted on a small experimental scale, the citrate may be thrown upon a stout cloth supported on a sieve or strainer, as soon as the water has drained away the residue is tied or folded securely in the cloth and submitted to pressure, to remove as much water as can be thus got rid of.

When a large quantity of citrate is made, a filter such as is used in citric acid works, may be employed, this consists of a "deal floor with boards round the edge; the floor has one inch splines nailed on it one inch apart. and canvas (36 in. "forfar") is stretched on the splines: a convenient size is 16 ft. x 12 ft. by 1 ft. deep. It should be slightly tilted and exit holes provided." (Grosjean) The citrate is allowed to drain upon the filter; when draining ceases the substance is put into canvas bags and submitted to pressure.

On a large scale it will be found more convenient to use filter presses; by their use the combined operations of filtering and pressing can be expeditiously performed, a great saving of time and labour can be thus effected, while the factory can be rendered much more compact owing to the small area occupied by the filter presses as compared with the space requiried for filters and the presses for the bags.

After as much water as possible has been pressed from the citrate by whatever process is adopted, it has to be dried. This part of the process demands great care, and is attended by considerable risk of loss; there is great tendency on the part of the citrate, when in a damp state, to ferment; as a result of this fermentation, the citric acid is destroyed and carbonate of lime, the original chalk from which the manufacture started, is left; there is little to indicate to the eye that this fermentive change is taking place, so that an unskilled or careless operator may find his finished product to contain no citrate

of lime at all, but to consist entirely of chalk. To avoid this risk of loss it is only necessary that the citrate of lime should be brought quickly into some form of drying apparatus where a temperature of from 150° to 200° Fh. (66–93° C.) can be maintained, while at the same time there is a free circulation of air through the drying chamber in order to carry away the moisture. For a long time the difficulty of obtaining a satisfactory and efficient drying apparatus was a great stumbling block: the problem of drying the citrate of lime is very similar in its nature to that of drying fruit, so that a good fruit dryer will answer well for experimental purposes, while larger forms of apparatus, worked upon the same principles, can be constructed for use where the manufacture is conducted on a large scale. Where much work is to be done it would appear desirable have several sets of drying apparatus, so that one lot of material may be thoroughly dried before it becomes necessary to introduce fresh, wet citrate into the same apparatus. Any form of apparatus in which the temperature can be maintained at from 150° to 200° Fh. or even somewhat higher, while at the same time permitting sufficient ventilation to remove the moisture rapidly, will prove efficient. It is important to lay stress on the ventilation. As has been stated the proper drying of the citrate is of paramount importance, should it remain damp, or in any way become damp from careless handling, or careless storing, fermentation will speedily spoil the product.

Messrs. Warrington and Grosjean* made an investigation of the amount of water remaining in citrate of lime dried at 212° F. (100° C.) they found this to range from 5·90 to 7·68 per cent., this exists as water of crystallisation; when dried at 392° Fh. (200° C.) the substance contained no water. Fermentation readily takes place if more than 12 per cent. of water is present, there is however no danger of fermentation as soon as the proportion of water has been reduced to 10 per cent. but it is desirable to continue the drying until less than that amount exists: if the temperature of the drying apparatus cannot be raised above 212° Fah. the product, as shown by the investigations just referred to, may contain over 7 per cent. of water, if however the drying can be finished at a higher temperature, say from 248° – 302° Fah. (120 to 150° C) the proportions of water may be reduced to below 5 per cent.: efforts should be made to secure this thorough drying.

When prepared in the manner described citrate of lime is a white powder free from hard lumps; when thrown into water it is easily wetted and is readily diffused through the liquid on stirring. If kept in a dry place it will remain good indefinitely. For shipment it should be tightly packed in paper-lined barrels. It should contain over 60 per cent. of citric acid; a sample prepared by myself contained 65.5 per cent. of citric acid 2.5 per cent. of other organic acids and .5 per cent. of carbonate of lime. Warrington states that the best sample of commercial citrate he has met with has contained 72 per cent. of citric acid, and this is about the hightest percentage that can be reached when the citrate contains no excess of chalk and has been thoroughly dried.

---

* Journ. Chem. Soc., Oct., 1875.

Citrate of lime is bought and sold on the same basis as concentrated lemon and lime juice, namely on the basis of citric acid contained. Quotations are made for the same arbitrary quantity as in the case of concentrated juice. In this case the standard is the cask of 675 pounds of citrate, containing 64 per cent. of citric acid; this being equal to 432 pounds of citric acid. As to price, citrate sells at about the same rate as concentrated juice, sometimes realising a little more, sometimes a little less than that article.

From the point of view of the manufacturer of citric acid, citrate of lime possesses some advantages over concentrated juice. It can be stored without loss, while juice is liable to leak from the casks: the first stage of the manufacture of the acid has been already completed and the manufacturer can dispense with the neutralising vats and the filters, thus there is much economy of space and of labour; finally owing to the fact that citrate of lime is white, while concentrated juice is black from the charring action of the heat used in its production, the resulting citric liquors obtained from citrate are a better colour, yielding whiter crystals of citric acid, thus reducing the operations of refining the citric acid and saving both labour and material.

Possessing these advantages it seems probable that citrate of lime will ultimately displace concentrated juice, provided that an article thoroughly suited to manufacturers requirements is produced; as competition becomes keener in the production of raw material—and this is likely to ensue from the attention being given to tropical products and the difficulty experienced in finding new and profitable ones—there will arise competition between these two forms of raw material, when the preference which the manufacturer of citric acid will give to well prepared citrate will no doubt enhance its value in comparison with concentrated juice. Hitherto the production of citrate of lime has been relatively small so that competition between the two forms of raw material can hardly be said to exist: it is not unlikely that this condition may be altered in the near future.

It has been proposed to undertake the manufacture of the citric acid itself in the countries where the juice is produced; this offers many obvious advantages, but at the same time is beset by some difficulties. The chief difficulty would appear to be a trading one; the manufacture of citric acid is in the hands of a few firms against whose interests small manufacturers could not contend, so that the probability of citric acid being made in the countries producing the raw materials seems remote unless the venture is undertaken by one of the already established citric acid-making firms.

The discussion of the pros and cons of this question would be too lengthy and technical to be profitably dealt with in this article; I therefore propose to reserve it, if necessary, for future consideration.

JAMAICA: WOODS FOR THE ROYAL YACHT.

The following letter has been received by the Director, Public Gardens, from Sir Frederick Abel, the Hon. Secretary and Director of the Imperial Institute, asking for samples of marketable woods and quotations of cost delivered in London.

The use of the woods in the interior fittings of a new Royal yacht would be an excellent advertisement.

Whenever possible, the samples should be planks showing average width obtainable and 8 ft. long, by 6 inches thick.

The Director, Public Gardens, can forward information and arrange for transport of samples, but cost of freight must be borne by those who are interested.

Woods that might be submitted are Satin Wood, Mahogany, Yacca, Mahoe, West Indian Cedar, Juniper, Coccus Ebony, Lignum Vitæ, Yellow Saunders and perhaps Yoke Wood and Santa Maria.

It is not necessary that all should be supplied by one person.

The woods sent should be true samples of what could be supplied in London, and should be sent before 31st March next.

Sir F. A. Abel to Director, Public Gardens, Jamaica.

Imperial Institute,
London, S.W.,
6th October, 1898.

Sir,

Enquiries have been made of the Imperial Institute as to whether it may be possible to obtain some Colonial Woods to be used in the interior fittings for the new Royal Yacht which will shortly be built, but it is desired to confine the selection to such woods as are either already, or likely to be, marketable. I shall therefore feel obliged if you will kindly make enquiries in Jamaica, with a view to samples and quotations being forwarded to me at the Imperial Institute within the next six months, together with information as to the probable cost at which such woods could be delivered free in London, *in a properly seasoned condition*, and within what date they could be so delivered.

You may perhaps be enabled to place me in direct communication with some individual firm or possible source, in the Colony, whence I could obtain the desired information and samples, it being of importance that definite intelligence on the subject should be received with as little delay as possible.

I am. etc.,

F. A. Abel,
Hon. Secretary and Director.

EXPERIMENTS WITH INSECTICIDES ON SCALE INSECTS.

It is so important for the future of the Orange industry that Scale-insects should be kept under control, that all should combine in attempts to destroy them.

Experiments are being carried on at Hope Gardens with insecticides, and many formulae have been tried. The following has so far been more successful than all others, and as it is cheap, and easily made, it is hoped that others will experiment with it, and note results.

Take a perfectly clean and dry bowl of a good size, pour into it half a pint of the cheapest Kerosine, add two pounds of soft soap, and work through the fingers vigorously until both constituents are thoroughly incorporated; the compound will then be of the consistency of putty and soluble in water.

It is advisable to mix only sufficient for one spraying, as it loses some of its insecticidal properties if kept for any length of time. It is also advisable to mix it in the sun as the warmth makes the ingredients combine more readily.

Disolve six ounces of the compound in half a gallon of rain (or boiled) water that has been warmed by the sun. When dissolved add a further 2½ gallons of soft water. The insecticide is then ready for use. Spraying should be carried out late in the afternoon, thus allowing the insecticide to remain in solution for a much longer time than if applied in the heat of the day.

With some scales one spraying is sufficient; but at other times three successive sprayings, four days between each are necessary to destroy them.

If the scales readily rub off after the application, it is a sign that they have been killed. Sometimes it happens that the spraying has no effect,—the scales adhere so closely that the insecticidal mixture does not penetrate, and then the scales do not rub off. In such cases the scales must be watched, and after a few days or a few weeks, spraying can be tried again. The best time to attack them is when the young ones have come from the mother scale, and are starting in life for themselves. In one case a yellow waxy-looking scale was noticed, on which the mixture had no effect until in about 6 weeks it turned colour and became a brown scale, then it was killed.

If only two or three shrubs in a Garden are affected, they can be treated with a feather, but it is generally necessary to use a spray pump, which can be purchased now in Jamaica.—(See Bulletin, February, 1897.)

FERNS: SYNOPTICAL LIST—LVII.

Synoptical List, with descriptions, of the Ferns and Fern-Allies of Jamaica. By G. S. JENMAN, *Superintendent, Botanical Garden, Demerara.*

ORDER VI.—*Salvinieæ.*

Annual aquatic floating herbaceous plants, of small or diminutive size, with imbricating or pinnatiform fronds and membranous major and minor capsules, which are situated in the axils of the leaves beneath, or in inferior clusters on branched filiform threads, and that contain, separately, sporangia of two kinds.

These are, in size, inconsiderable aquatic herbs, which exist usually in great abundance, floating on the surface of still water, and are especially common in Guiana. The known species are about a score or more, which are spread through the torrid and the warm temperate regions of both hemispheres.

Genus I. *Salvinia,* Schreb.—Capsules membranous, indehiscent, globose, clustered in descending panicles, singly at the end of short pedicels, borne among the roots, the smaller, which are fewer, superior, and on longer pedicels, containing few reticulated macrosporangia ; the larger, inferior, more numerous, on shorter pedicels, containing multitudinous reticulated microsporangia.

Small floating aquatic herbs, communal in habit, with serial fronds on a more or less shortly-extended rachis, entire, flat or partially folded, with close parallel pinnatiform veins, and tufts of numerous, descending simple villous roots. Like the next, all the plants of this genus bear a common general resemblance, differing mainly in the degree of elongation of the axis, and size, form, colour and vestiture of the leaves, &c. The capsules are globose, and hang in loose clusters among the leaves, each one on separate pedicels which radiate more or less from the common axis. Those containing the macrosporangia, though situated above, reach out beyond those containing the microsporangia, which are larger, having pedicels twice or more as long. The fruit, roots, and fronds all spring from the joints in the rachis, which is the thickness of moderately thin string, the intevening space being destitute.

1. *S. auriculata,* Aulet.—Rachis horizontal, cord-like, nearly a line thick, puberulous with slight scales, extending a few inches and branching; fronds contiguous or apart, two at each joint, spreading at right angles, on petioles $\frac{1}{4}$ - $\frac{1}{2}$ in. l. which are clothed like the rachis, the blades folded at first, rounded, cordate at the base with rounded auricles, $\frac{1}{2}$ - $\frac{5}{8}$th in. each way, herbaceous. cloudy green, pubescent beneath, densely strigose above with elongated glands that are divided into three or four filaments at the end, and mixed with finer ones ; veins very close and numerous ; capsules of microsporangia nearly 1 li diameter about 2-6 in number, those of the macrosporangia half the size and about 1-3 ; both pubescent.—Aubl. guian. 2,969 t, 367. Bak. Fern Al. p. 136 *S. rotundifolia,* W. *S. Hispida,* H. B. K. *S. biloba,* Raddi. I have not seen Jamaica species but include it to be looked for, for it is probably found on some of the Bri-

tish West India Islands, though not yet recorded. In estates' trenches, ponds and ornamental waters, this plant is a pest, from the freedom with which it multiplies and the multitudinous number of the individuals. The capsules are two to nine in number, or perhaps more, about from one to three (sometimes none) of each cluster containining macrosporangia.

Genus II: *Azolla*, Lam. Capsules situated in pairs in the axils of the leaves beneath, of two kinds, membranous, indehiscent; the larger, subglobose, containing several or many microspores; the smaller ovoid, containing a solitary macrospore. Very small communal floating weeds, branched, with miuute imbricating leaves in a double series, sessile, with no veins, a central rib only in each, the inferior smaller than the superior, and descending filiform simple villous roots. The members of this genus like the last are communal and form a sheet over water, often quite concealing the surface. They are exquisite little plants in structure and colour, with minute imbricating leaves, varying from green to dark purple in colour, branched in the form of little prostrate trees. The species are about half-a-dozen, tropical and subtropical, found in America, Asia, Africa and Australia.

1. *A. Caroliniana*, Willd.—Entire plant $\frac{1}{2}$–$\frac{3}{4}$ in. each way, deltoid or flabellate in outline, pinnate or bipinnate, obtuse, lower branches longest, the lowest shortly branched again at the ends, leaves all united at the axis, biserial on each side, those of the upper series larger, more fleshy, brighter coloured, more erect and less appressed, subovate, $\frac{1}{2}$ - $\frac{3}{4}$ li. l., less broad; those of the under side gray, appressed one on the other; sporangia in pairs, one of each or both of one kind together in the axils of the leaves; macrosporangia several times larger than the microsporangia, globose-oblong, the sack tender, membranous; spores uniform or variable in size spherical, pitted or reticulated, 6 - 24 to a capsule, microsporangia ovoid, dark coloured, or striated, at each end. The colour varies from light green to dark purple, but there seem to be two varieties—green shading to pink, and pink shading to deep purple, the former being larger in both plant and leaves. The sporangia as a rule can only be detected by the use of a simple microscope, but the macrosporangia may sometimes by the naked eye be seen to be of a pale green colour, protruding between the leaves. Bak. Fern. Al. p. 138. My description is taken from Cuban specimen. The range is so wide that there can be little doubt the species only waits to be recorded from Jamaica and some of the other islands.

Tribe XIV.—*Gleicheniece*.*

Sporangia sessile, globose or subglobose, having a broad, complete, transverse equatorial jointed band; eventually bursting on one side from top to bottom; sori superficial on the back of the veins, punctiform, composed of few or several sporangia; involucres none.

The principal characters which distinguish this tribe are,—sporangia sessile, globose, ring horizontal, equatorial, the rupture vertical. The physiognomy, general habit, and manner of development of the fronds are also singular. There is only one American genus.

---

* This tribe was unfortunately omitted in its proper place. It ought to have come in at page 155 of this volume.

Genus XXXVI. *Gleichenia*, Smith.—Fronds with distant opposite lateral pinnæ, which spread at a wide angle from the stiff erect and often subscandent stems; sori punctiform, superficial, medial on the veinlets; sporangia 3–12 (rarely more) to a group; veins forked, free; pinnæ in most cases repeatedly forked and flabelliform, having scaly or leafy auxillary buds; pinnulæ or ultimate branches pectinate.

A well marked group of plants, of singular habit and communal proclivities, diffused very abundantly throughout the country from the lowest to the highest elevations, covering roadside-banks and extensive tracts of open land and not very densely shaded forest, where they form entangled and hardly penetrable thickets, and in open situations monopolise the entire possession of the ground. In all the species the rootstock is slender, wide-extending and branched, and runs under the surface of the soil, the fronds arising at intervals on its axis. They have slender but stiff more or less glossy stems about as thick as a quill, from one or two to several feet long, to the upper part of which the branches or pinnæ, developed, as before said, in opposite pairs, are confined. In most of the species here included the sori often present a diffused character, from the varying number of capsules to each group.

Sporangia 3-5 in each sorus.
Pinnæ flabellately forked,
Fronds densely tomentose beneath.
1. G. pubescens

Fronds paleaceous.
2. G. furcata.
3. G. Matthewsii.

Pinnæ not dichotomous, but regularly pinnatiform in branching.
4. G. Bancroftii.

Sporangia 12 or less in a sorus; rachises zigzag.
5. G. dichotoma.
6. G. pectinata.

1. *G. pubescens*, H. B. K.—Stipites and rachises strong deciduously furfuraceous or paleaceous; pinnæ in 1-4 distinct pairs, dichotomous, the primary petioles 2-5 in. l., scariously margined, with a few shortened leaf-segments at the base on the inner side only reaching a third or half way up, or entirely devoid of any, deciduously furfuraceous or paleaceous; secondary petioles lined with leaf-segments throughout, or a few absent only on the outer side; pinnulæ pectinate, ¾ - 2 ft. l., 1½ - 3 in. w., broadly divaricating, rigid, gradually tapering outwards; ultimate segments linear, ¾ - 1½ in. l. 1 - 2 li. br., obtuse or acute, expanded and contiguous at the base; the upperside naked or deciduously furfuraceous, especially on the costules, beneath very densely coated with a thick layer of rusty or grayish feltlike tomentum, the costules naked or paleaceous; the margins flat or reflexed; veins once forked; sori copious; sporangia 3 - 5 in a group, immersed and more or less concealed in the tomentum.—*Mertensia immersa*, Klf. *M. ferruginea*, Desv.

General throughout the country, forming thickets in open and half open situations from sea-level up to 5,000 or 6,000 ft. altitude.

Readily recognised by means of the undercoating of dense fur-like tomentum, and long rigid tapering pinnæ. The vestiture of the stems and rachises varies considerably, the Jamaica specimens being mostly naked. The colour of the tomentum varies too from gray to rufus. The large states are often mistakingly ascribed to *G. longipiumate*, Hook., (*Mertensia*, Klf.) a quite distinct plant, founded on Hostman, n. 228.

2. *G. furcata*, Spreng.—Stipites and rachises strong, the immature clothed with ragged rufous scales, that ultimately become pale and drop away; pinnæ in two or three pairs, spreading fan-like, the ends of the pinnulæ drooping, tri-or quadri-chotomous; primary petioles devoid of leaf-segments, as are also the secondary, but more or less clothed with red laciniate scales; costulæ scaly beneath, and rusty tomentose above, 1¼–2 in. w.; ultimate segments linear, close and parallel, ¾–1¼ in l., 1–1½ li. w., naked above, but with very minute scattered grayish stellate scales beneath; veins once-forked; sori not plentiful; sporangia 3–4.—Pl. Fil. t. 28. *Polypodium*, Sw. *Mertensia furcata*, Willd.

Very common in the mid-region of the great mountain range, above and below 4000 ft. altitude, in forest and on more or less open banks and waysides. Distinguished from the preceding by the plentiful rufous scales, its more repeatedly divided pinnæ, narrower and closer ultimate segments, which, too, are absent from the petioles of the primary and secondary divisions, and unmistakeably by the absence of the undercoating of matted tomentum which characterises that species. When growing in the open, the scales contribute a faint aureous tinge to the leafage, by which it may be recognised at a distance. The opposite pinnæ spreading from, and laterally toward, each other, with the ends of the pinnulæ drooping, are altogether quite umbrella-like in form. The texture is rather brittle and both the pinnulæ and segments of old leaves are often much broken. The segments are usually somewhat irregular in length. This by its more repeated branching is the most leafy of the associated species.

3. *G. Mathewsii*, Hook.—Stipites and rachises strong, dark brown, deciduously paleaceous; pinnæ in two or three spreading pairs, di-trichotomous; primary petioles usually lined on both sides at the base with leaf-segments, secondary ones lined thus throughout; pinnulæ 6-10 in. l. ½-1 in. w., naked on both sides, beneath slightly glandulose and subglaucous; gemmae foliaceous, and with the petioles and costulæ densely clothed with chesnut-coloured lacinate-edged acuminate broad-based scales,—the costulæ so only beneath; ultimate segments rather bluntish or acute, ¼ over ½ in. l. 1-1½ li. w. the edge often revolute; veins once forked, sori sparse; sporangia 3-4 in a group.—Hook. Sp. Fil. p. 9 t. 7 B. *Mertensia farinosa*, Klf.

Exceedingly abundant along the ridges and higher slopes of the Blue Mountain range, ascending the highest peaks, where it forms dense thickets. It is separated from *G. furcata* by its smaller and less compound pinnæ, which are more copiously clothed with scales and more glandulose, by the absence of the stellated scattered scales on the underside of that species, and by the presence of the leaf-segments at the base of the primary petioles. The presence or absence, more or less, of this petiolar leafage is a good, though slightly variable, character in distinguishing one from another this and the two preceding species.

The scales of the stems are appressed and more or less imbricated, especially about the nodes and buds, but deciduous. The outer pinnulæ are much more curved generally than in either of the allied preceding species, of which character the inner ones in a lesser degree often partake. There are two forms—a broader and narrower, a variation which, perhaps, may be due to difference in altitude. The latter, in which the ultimate segments are only ¼ inch long, and the edges revolute, comes near *G. revoluta*, H. B. K., for which species a specimen, gathered by Purdie in January 1843 on the top of Blue Mountain peak, was mistaken and is so ascribed in Hooker and Baker Syn. Fil.

4. *G. Bancroftii*, Hook.—Stipites and rachises strong, glossy, naked, with one or two (usually one) pair of long, oblong, acuminate pinnae at the top extended at right angles, arch-like ; terminal bud densely clothed with linear-acuminate light-brown scales ; pinnae bipinnate, 3 - 5 ft. l. 15 - 20 in. w.; pinnulæ close and very numerous, spreading at right angles and parallel, 6 - 10 in. l. 1 - 1½ in. w., sessile, acuminate; ultimate segments close, linear, acute, the edges often reflexed, ¾ - 1 in. l. 1 - 1½ l. w. ; the inferior ones free and subcordate at the base on the upper side, adnate and shortly decurrent on the lower; costae with two raised light-coloured marginal lines down the face, surface glabrous, pale green above glaucous beneath; texture rigid; veins once, or rarely twice, forked, sori sparse or copious ; capsules 3 - 5 in a cluster; receptacle ciliate with a few lanate scales. *Mertensia glauca Jamaicense*, Swartz. *M. Bancroftii* Kze. Pl. Fil. t. 25.

a. var *gracilis*, Jenm.—Pinnae 1 - 2 ft. l.; pinnulae finely pectinate, ½ in. w.; segments ½ li. w.

Very abundant on the skirts of forests and more open places at 5,000-6,000 ft. alt. A fine well marked species of singular habit, not to be confounded with any of the rest included here. Generally it has only one pair of pinnae which spread like outstretched arms on opposite sides at the top of the petiole. There is a form in which the segments extend into a pectinate state like the normal pinnules. In Hook and Bak, Syn. Fil. this is included with the Old World *G. longissima* Blume.

5. *G. dichotoma*, Willd.—Stipites and rachises naked; pinnæ in two or three pairs, flabelliform, di-tri-chotomous, having in addition to the auxiliary foliaceous bracts a pair of divaricated deflexed basal pinnulæ with serrated or subentire points, subtending the forks, uniformly pectinate, but much shorter than the primary pinnulæ; the latter 6–10, in. l. 1½–2 in. w.; petioles slender, not flattened or margined on the face, and naked ; ultimate segments ¾–1 in. l. 1½–2 l. w. at the dilated and slightly connected bases, the margin slightly reflexed or revolute, obtuse or acute and emarginate at the point; surfaces naked pale green above, glaucous beneath; veins 1–3 times forked ; sori copious ; sporangia 12 or less in each cluster. *Mertensia*, Willd. *Dicranopteris*, Bernh. Sl. Herb. p. 168.

Abundant in situations from the lowlands up to 5000 ft. altitude, but not so common and generally diffused as its close ally *pectinate.* Its more compact habit, strictly and uniformly di-or trichotomous pinnæ, with the pair of deflexed accessory inferior pinnules to each fork, unmistakably mark it.

6. *G. pectinata*, Pr.—Stipites and rachises naked; pinnæ in two or more laxly extending pairs, 1–2 ft. l., with distant alternate branches, which are once-forked, or the inferior ones again branched with similar forked pinnulæ, petioles slender, cartilaginous-margined, devoid of leaf-segments but usually with foliaceous bracts in the axils at the base; pinnulæ 6–10 in. l. 1½–2 in. w., linear lanceolate acuminate, outer side wider at the base than the inner, which is usually somewhat reduced there; ultimate segments linear, bluntish, emarginate, 1–1½ in. l. 2 l. w. at the rather dilated and connected bases, pale green above glaucous beneath, naked or slightly rusty-tomentose on the veins, which are 2–3 times forked, sori usually not plentiful; sporangia in clusters of 12 (13) or less; Hook. and Grev. Icon. t. 14. *Mertensia,* Willd. *Dicranopteris,* Bernh.

Generally diffused among the lowlands, and ascending to nearly 6,000ft. elevation. Much more common than its ally, *dichotoma,* to which it bears a general resemblance but is clearly distinguished by habit. Its chief features are the long lax pinnæ, the branches of which are arranged alternately, the slender petioles being flattened on the face and slightly margined by cartilage, and the absence of the axillary pair of pinnulæ which subtend the fork of that species. There is an intermediate form common about Mt. Moses, broader with the habit generally of *pectinata* but approaching *dichotoma* by a tendency to develop a pair of deflexed basal pinnulæ. The mainland form, found too on some of the West India Islands, is much narrower in its leafage, and with rusty hairs clothing the veins beneath.

ADDITIONS AND CONTRIBUTIONS TO THE DEPARTMENT.

Library.

Bulletin, Kew Gardens. July–Nov. [Director.]
Chemist & Druggist. Oct. 22, 29. [Editor.]
Journ. R. Horticultural Soc. Oct.
Garden. Oct. 22, 29. [Purchased.]
Gardeners Chronicle. Oct. 22, 29. [Purchased.]
Nature. Oct. 20, 27. [Purchased.]
Pharmaceutical Journal. Oct. 22, 29.
Produce World. Nov. [Editor.]
Record R. Bot. Soc. London. Jan. Feb. Mar. [Secretary.]
Sugar Cane. Nov. [Editor.]
Sucrerie Indigène et Coloniale. Oct. 18, 25. Nov. 1. [Editor.]
Annales L'Institut Coloniale de Marseille, 1895–98. [Editor.]
Tropenpflanzer. Nov. [Editor.]
Mycologische Studien von G. Lagerheim, I. Stockholm, 1898. [Author.]
Agricultural Ledger. No. 9–11. [Supt. Govt. Ptg. India.]
Report Govt. Cinchona Dept. Madras. August. [Govt. of Madras.]
Tropical Agriculturist. Sept. Oct. [Purchased.]
Queensland Agr. Journ. Oct. [Sec. Agri.]
Agr. Journal, Cape of Good Hope. Sept. 29. [Agr. Dept.]
Bulletin Agricole de la Martinique. Aug. Oct. [Editor.]
Journ. Jamaica Agr. Soc. Nov. [Sec.]
Proc. Agricultural Soc. Trinidad. Oct. 18. [Sec.]
Central African Times. Aug. 20. Sep. 3. [Editor.]

Bulletin U. S. Dept. Agr. Div. of Pomology No. 7. The Fruit Industry. [Sec.
Trans. Massachusetts Hort. Soc. 1897. Pt. III. [Sec.]
Journ. Cincinnati Soc. Nat. History. IV–XVIII, XIX, 4. [Editors.]
Fern Bulletin. July. [Editor.]
American Journal of Pharmacy. Nov. [Editor.]
Trans. Kansas Academy of Science. 1893.94. Vol. XIV. 1896. [Librarian.]
Bulletin Torrey Botanical Club. Nov. [Editor.]

Publications of the following Agricultural Experiment Stations U. S. A. [Directors.]

California 120	Ohio 94
Illinois 51, 52, 53	Wyoming 37

Origin of Gymnosperms and the seed habit. Prof. J. M. Coulter. [Author.]

Contributions from the Dept. of Botany, Columbia Univ. Vol. 6. Nos. 126–150, 1897–1898. [Prof. L. M. Underwood.]

Montreal Pharmaceutical Journ. Nov. [Editor.]
Hawaiian Planters Monthly. Oct. 1898. [Editor.]

Seeds.

From Supt. Botanic Gardens, Demerara.
Castilloa elastica.

From Dr. Plaxton, Kingston.
Erythrina sp.

Plants.

*From Botanic Station, Dominica.**
Durian.
Talauma Plumieri.
Tubers Wild Yam (Rajania pleioneura).

From Dr. G. C. Henderson, Kingston.
Laelia albida.

Herbarium Specimens.

From G. Ewen, Esq., Falmouth.
Canavalia obtusifolia.
Phaseolus sp.

* Omitted by oversight from a previous list.

[Issued 30th January, 1899.]

New Series.] APPENDIX, 1898. Vol. V. App.

BULLETIN

OF THE

BOTANICAL DEPARTMENT, JAMAICA.

EDITED BY

WILLIAM FAWCETT, B.Sc., F.L.S.

Director of Public Gardens and Plantations.

CONTENTS:

PRICE—Threepence.

A Copy will be supplied free to any Resident in Jamaica, who will send Name and Address to the Director of Public Gardens and Plantations, Kingston P.O.

KINGSTON, JAMAICA:

GOVERNMENT PRINTING OFFICE, 79 DUKE STREET.

1899.

JAMAICA.

BULLETIN

OF THE

BOTANICAL DEPARTMENT.

New Series.] APPENDIX, 1898. Vol. V. App.

Report of the Director on the Department of Public Gardens and Plantations for the year ended 31st March, 1898.

W. I. R. Commissioners on Botanic Gardens.

Since the appearance of the last Report, the West Indian Royal Commissioners have presented their Report to Parliament. In it they state in paragraphs 121—127 :—

" The Botanical establishments in the larger Colonies, such as Jamaica, Trinidad, and British Guiana, have already rendered considerable assistance in improving agricultural industries, and they are capable of being made increasingly useful in this respect. In the Windward and Leeward Islands and Barbados, small establishments called Botanic Stations were established a few years ago on the advice of the Director of Kew Gardens, and the results, though not yet extensive, have been of a distinctly promising character. It is evident that to grapple with the present circumstances, there is required for the smaller islands a special public department capable of dealing with all questions connected with economic plants suitable for growth in tropical countries, and we recommend the establishment of such a department, under which should be placed the various botanic stations already in existence. These stations should be enlarged in their scope and character, and be organized on the lines found so successful in Jamaica. In the latter Colony it is admitted that intelligent and progressive action in the direction of encouraging a diversity of indus-

tries has produced most satisfactory results. To achieve this result has, however, taken more than 20 years of persistent effort, and the Government has spent more than £100,000 during that period on its botanical establishments. The department has distributed seeds and plants at nominal prices by means of the Post Office, Government Railways, and Coastal Steam Service; it has supplied information orally, or by means of bulletins, regarding the cultivation of economic plants, and has encouraged the careful preparation of the produce by sending agricultural instructors on tour through the island, to give lectures, demonstrations, and advice."

"The special department recommended for carrying on similar work in the Windward and Leeward Islands should be under the charge of a competent Imperial Officer, whose duty it would be to advise the Governors in regard to all matters affecting the agricultural development of the Islands. He would take part in consultation with the object of improving agricultural teaching in colleges an schools, and of training students in agricultural pursuits, and woul attend to the preparation of suitable literature on agricultural subject The existing botanic stations should be placed under his supervisio and the charge of maintaining them transferred to Imperial fund Each botanic station would be actively engaged in the introductio and improvement of economic plants, and in propagating and di tributing them throughout the Island. It would carry out the e perimental cultivation of new plants to serve as an object lesson cultivators, and it would be prepared to give the latest informat to enquirers regarding economic products, and to provide suitable m as agricultural instructors. To effect all this will require funds entir beyond the present resources of the smaller Islands. We are, the fore of opinion that as the necessity for such a department is urg the cost should be borne by the Imperial Exchequer."

"The promising experimental work connected with raising varieties of canes, and increasing the production of sugar by the of manures and other means should receive special attention. Th of some of this work would be a legitimate portion of the charge above stated. The chief experiments might be carried on as hitherto by the officers in charge of them in British Guiana, Barbados, and Antigua, but continued and extended, if found desirable, in Trinidad and Jamaica. In addition, the botanic stations in the Windward and Leeward Islands, would maintain nurseries for the introduction of all new and promising canes, and would undertake the distributing them within their respective spheres of action." . . . . .

"At the present time a system of training in agricultural occupation is much needed. We think that some, at least, of the botanic stations should have agricultural schools attached to them, where the best means of cultivating tropical plants would be taught, and if elementary training in agriculture were made a part of the course of education in the public schools generally, the Botanic Department would be in a position to render valuable assistance."

"Agriculture, in one form or another, must always be the chief and the only great industry in the West Indies, but a system of training in other industrial occupations, on a limited scale, is desirable, and would be beneficial to the community."

Imperial Department, and Jamaica Department.

The Royal Commissioners thus appear to have founded their recommendations for the new Imperial Department, mainly on the work which they ascertained, was being carried on in Jamaica.

It will be useful to compare the area, population and revenue of the Islands which will receive the fostering care of the Imperial Government, and the expenditure proposed under the new Department, with the area and the expenditure of Jamaica.

The figures in the following table are for the year 1896, and are taken from the Colonial Office List :—

	Area Sq. Miles.	Population.	Revenue. £
Leeward Is., Windward Is., Barbados, Tobago	1,508	480,076	471,606
Jamaica	4,207	694,491*	777,133

Comparing these figures. it would appear that approximately for every £2 spent by the Imperial Government on the other Islands, Jamaica should spend £3 or half as much again.

The following table compares the estimates by the Imperial Government of the expenditure which they consider necessary, and the estimate for the year 1898-99 of the Jamaica Department :—

Department of Agriculture in Leeward and Windward Islands., Barbados and Tobago.		*Department of Public Gardens and Plantations in Jamaica*	
Chief Officer ...	£1,000	Director ...	£600
Clerk and travelling Superintendent	600	Clerk and Assistants	368
Eight Curators and ten Instructors	3,070	Six Superintendents	903
Travelling and Office expenses	600	Travelling and other charges including Bulletin	502
Bulletins and Leaflets	500		
Nine Gardens and experiment stations	4,630	Six Gardens†	2,332
Total	£10,400	Total	£4,695
Four Industrial Schools	£2,000	Other charges not on Estimate-	
Additional grants :—			
Horticultural Shows	500	One Industrial School	£680
Agricultural teaching in elementary schools	500	Agricultural Society	2,000
Agricultural teaching in Colleges and Schools	2,600		
Sugar Cane experiments in British Guiana	1,000		
Grand Total	£17,000	Grand Total	£7,375

* From the Report of the West India Commissioners.

† Including three—King's House, Bath and Kingston Gardens, which are not Agricultural Gardens.

The Commissioners have doubtless put the expenditure which they considered necessary at the lowest possible figure ; and if we remember that the area of Jamaica is nearly three times that of all these Islands put together, and the population and revenue half as much more, the proportionate expenditure on the Jamaica Gardens should be nearer £16,000 than £5,000. The Department is run very cheaply, but the saving effected in this way, cripples its work, and prevents expansion in many directions.

The expansion that is more particularly required is in the direction of more agricultural instruction. Mr. Cradwick's whole time could very usefully be employed in travelling throughout the length and breadth of the land, showing the peasantry, and others who desire help, improved agricultural methods. In order to reach children in elementary schools, the students in training colleges should be enabled to have 2 or 3 months of work annually at the Gardens. Agricultural training of higher grade might be commenced in a tentative way.

Experimental station work comparable in any degree with that in the United States can only be undertaken at a cost which at present appears to be prohibitive. Scientific experts would be required for each branch, laboratories with appliances and instruments, plots of ground, and farm animals for experiment with the labour necessary in each case.

Hope Gardens and Distribution of Plants.

Hope Garden is now the head-quarters of the Department. The Director's residence and office, the herbarium and library, are all situated there.

The area is altogether about 212 acres, and of these about 120 acres are cultivated and kept in order. A part is laid out as a botanic garden ; a portion is devoted to growing Sugar Canes, Pine Apples, Tobacco, Citrus Plants, etc., for distribution and experiment ; and part serves as pasture for mules, etc.

Hope is also now the centre of distribution of plants and seeds.

The propagation and distribution of plants, generally a quarter of a million in number, during the year, will compare favourably with the work of the largest Nursery Gardens, and if the whole cost of the Department, including salaries, were placed against these plants, the cost to the Island would in that case be only about 3d. each. Mistakes are occasionally made, and accidents occur, but I believe the following letter expresses the general opinion throughout the Island :—

"If the Public Gardens did nothing beyond supplying plants to applicants in different parts of the Island, it would have conferred considerable benefit on the Island. I have heard on all sides that the various plants supplied by the Gardens have given great satisfaction. My attention has been particularly directed to the beautiful and effectual manner in which Orange and Grape Fruit plants are put up for distribution. The excellent Cocoa plants supplied me some little since time are doing exceedingly well, and all the ornamental shrubs supplied have proved a success."

The expenditure at Hope Gardens may be arranged under the following heads:—

		£	s.	d.
Maintenance of Garden	...	394	0	0
Plant Nurseries	...	496	0	0
Labour on Economic Plants	...	160	0	0
Transport	...	170	0	0
Packing Cases, Bamboo Pots, etc.	...	200	0	0
Sheds, Carts, Harness, Tools, Fences and Water Pipes		100	0	0
Water Supply	...	131	11	0
		£1,651	11	0

Of this amount £1,116 11s. 0d. is provided on the Estimates,—the expenditure on transport, packing cases, etc., and on part of the nursery work being met by the receipts from sales of plants. By the aid of the receipts for the past four years, I have been able to increase the distribution of plants to an unprecedented extent, and to place the benefit of the Nurseries at the disposal of planters in all parts of the country, without regard to distance. Wherever the Coastal Steamer stops in her voyage round the Island, wherever there is a Railway Station, there plants are sent at exactly the same cost to the purchaser as if he were living in or near Kingston. In fact, failing the Railway and the Steamer as means of transport, wherever the Mail Coach or the peripatetic postman penetrates, parcels of plants from the seedbeds as well as cuttings and seeds are distributed. The humblest peasant without having to pay postage, can send a half-penny to the Director and get a Cocoa plant in a bamboo pot in return, at any port or railway station; or he can have at any Mail Coach or Parcel Post Office, if there is no port nor station convenient, such a plant as an Orange or Grape Fruit seedling which does not require a pot, or he can get seed of the finest cocoa. By simply stating the area he intends to plant in tobacco, anyone can have free as much as he requires of Havana or Sumatra tobacco seed.

A planter and pen-keeper writes as follows:—"I look upon all the Public Gardens as immense blessings to the Island, the more we can spread economic plants over the whole Island, the better for our exports, and the more we can foster the love of flowers among the people the happier they will be. With all our present lack of money I hope nothing will be done to curtail the usefulness of the Public Gardens, which are a credit to the Island and to all who manage them."

Visits to the Gardens.

Visits to the Gardens for the purpose of learning something about products new to planters are frequent. One writes:—"Information that I have got from you, and by my several visits to the Gardens have been invaluable to me, and has opened quite a new era for me in cultivating. I wish the Gardens every success, as they have benefited me and indirectly hundreds of small settlers in this district, for they, seeing the benefits accruing to me from improved methods of cultivating and the introduction of new plants to the district, are following suit,—and thereby increasing their prosperity, and also that of the country."

Bulletins.

The Bulletins published during the year contained articles on the following subjects:—

Satin Wood.
Pea-nut or Pindar-nut.
Oil Tree.
Coneys and Nutmeg Tree.
Notes on Recent Additions to the Gardens.
Reasons for Cultivating the Soil.
Commercial Fertilisers.
Coccidæ, or Scale insects.
Ramie.
Ferns—Synoptical List.
Grape Industry.
How to gather Logwood Seed.
Leguminous plants for green manuring.
Barnyard Manure.
Movements of Plants.
Analysis of Sugar Cane.
Elementary notes on Jamaica Plants.
Cabinet Woods: Market Report.
Rhythmic growth in Citrus.
Ceara Rubber.
Carob or Locust Bean Tree.
Citric Acid.
Plants grown in Castleton Gardens.
The History of the Public Gardens and Plantations.
Notes on Orchids.
Cocoa in Trinidad, Venezuela and Grenada.
Rubber.
Note on Ceara Rubber.
Wax Palms of the Andes.
Oka of Peru.
Agricultural Chemistry of Cocoa.

Correspondence.

The correspondence has been as large as usual. It is impossible to attend to all the foreign letters that are addressed to me, and I have had to adopt some rule in dealing with them. I answer letters of enquiry asking for information about the Island and its products, from persons who are thinking of settling here; I try to help those who have any claim on the Island by reason of being countrymen, or being willing to reciprocate; but wherever there already exists a botanic garden, I think it only right to confine my correspondence to the Officer in charge, and leave him to supply information, seeds, plants, &c., to local people.

Field Instruction.

Mr. Cradwick's work is exceedingly important, and it would be well to vote such money as would allow him to devote his whole time to it; —say, £400 for travelling expenses, and £250 for a Superintendent to take his place at Hope.

It has been remarked that it would be well that Mr. Cradwick's instruction should be more systematic, and on the lines of that given by

the lecturers for the County Councils in England. This is a somewhat unfortunate statement, for it is pretty generally known that the system pursued in England has been somewhat of a failure, whereas the plan in Jamaica has been most successful. Without more detailed criticism than this, it is impossible to do more than guess at the meaning here of "systematic". Probably it means that a series of lectures running through the fundamental principles of agricultural science should be given in definite centres at stated times. This might answer in countries that are more advanced in general education and knowledge of agricultural practice. But our chief aim at present is to reach the peasant class, who cannot read well enough to appreciate printed matter, or who cannot get just the kind of information he requires.

He wants to know why his cocoa tree is not bearing as well as the trees on the big estate close by; why his trees are always covered with moss, while his neighbour's are clean; why some trees have died out completely from the roots up; how he can cure his cocoa, so as to get the best price for it. The Instructor must go into the fields with the people, he must see their cultivation, and point out what is wrong, and how to improve; he must talk over with the people their difficulties, do some work on the spot with their own land and their own plants, that they may watch what difference the draining of the land or the pruning of the trees makes in the crop, and in the general health of the trees. This method is truly scientific and truly systematic. It is supplemented by talks (a lecture, if the term is preferred) to larger audiences in school-rooms wherever there is a good centre. These talks also are much appreciated; they last about an hour, and then for about another hour or two, the Instructor is engaged in answering questions put by his hearers. The questions are generally very much to the point, and show a strong desire to learn, and to improve their practice.

Our system with regard to choice of centres is to try to confer the greatest good on the greatest number. In the first place our hands are tied by want of money. Instructors will not travel round at their own expense from philanthropic motives. Again I cannot detach men from work which has a prior claim, and would fall through if left. We want more men and money. With the limits imposed at present, we cannot do anything on what may be called the missionary side of agriculture,—going into new districts, and stirring up people to recognise their agricultural sins. The Instructor is not sent to any district, unless the people in large numbers desire it, and manifest their wish by signing a petition to the Government. Even then, unfortunately, we are not able always to comply with the request. Some choice must be made with our limited means, and as I have said, our choice is determined by the principle of the greatest good for the greatest number.

If the method were adopted of giving a series of lectures at each centre, I feel sure that the result would be failure. The people are not accustomed to leave their work and walk miles day after day to listen to a lecturer.

I have to thank the Clergy and others in various places for kind help in arranging for Mr. Cradwick's visits. Whatever success we

may have had, depends in very great measure on the interest taken in this work by local men "of light and leading."

The following extracts are from reports by Mr. Cradwick —

Portland.

"I beg to submit the following report on a lecturing tour in the Parish of Portland.

"Tuesday, April 27th, 1897. Lectured in the Belle Castle School Room, on the subjects advertised :—Cocoa, Coffee, Oranges and Grape Fruits, to an audience of about 60 adults.

"Wednesday, 28th. Demonstrated on the above subjects in several Gardens at Belle Castle, and also paid a visit to Hector's River in order to advise the proprietor with reference to his Cocoa cultivation. At 7 p.m. the same evening delivered a second lecture, pointing out and emphasizing the mistakes and errors observed when going through the district.

"Thursday, the 29th. Lectured to an audience of about 100 in the School Room at Manchioneal, and afterwads demonstrated in some Gardens near by.

"Friday, the 30th. Rural Hill. Only about 30 people turned out. The people here seemed to be prejudiced against anything of the kind through their disappointment in connection with their efforts to secure crown lands, which they assert had been promised them, and for which they had paid money to some agent of the Government as long ago as last year, and up to that time no land had been allotted them, but that the Government still had their money.

"Saturday, May 1st. Boston. Here an audience of about two dozen only had gathered; the people were also aggrieved or sympathised with the people who have a grievance over the Crown Lands. However the people who did come out were of the best, and the most industrious of the neighbourhood; they were really interested in what I had to tell and show them, and expressed strong hope that I would return at an early date.

"The portion of the Island visited during this tour, is, I regret to say, one of the most backward agriculturally which I have yet visited. The coffee and chocolate are simply allowed to grow,—no attempt at planting at a proper distance is made; no attempt at regulating the growths of the large trees through which the coffee is growing; no attempt at pruning; in fact no attempt (with just here and there a feeble exception) at any kind of cultivation is made at all. Chocolate is simply allowed to grow up into huge poles with scarcely even a pod on them. The district is famous I am told for good grape fruits, yet the people are not planting,—I did not see one single young plant outside the large properties except such as had grown spontaneously. A large number of young sour oranges were growing through the district, and I carefully showed the people how to bud these, and hope that they will carry out the instructions. I carefully impressed on them the need of a more systematic style of cultivation, for it is really pitiful to see so much fine land put to so little use. The audiences, although small, were I think of the right class of men, and I think that some at least in every district will try to put my ideas to a practical application.

St. Ann.

Monday, 17th May.—Lectured at Mount Moriah at 2 p.m. about 40 adults present, subject treated, the growing, pruning and curing of coffee, also the growing and pruning of oranges; rain prevented any demonstration in the fields.

Tuesday, 18th.—Johns Hall. Lectured on growing, pruning and curing of coffee, also growing budding and pruning of oranges. This being a wet district and the soil heavy and retentive, particular stress was laid on the proper methods of draining, and the benefit to be derived from a properly carried out system of drainage. Demonstrated on pruning coffee and budding oranges.

Wednesday, 19th.—Clarksonville. Gave a demonstration on Mr. Head's property, on the proper way to manure, fork, and to prune coffee; also how to bud and prune oranges. Some coffee which Mr. Head had taken in hand since the occasion of my last visit and had forked and manured, but not so effectually as it might have been done, had improved wonderfully. The improvement no doubt would have been still more marked but for the late severe drought.

Lectured at noon in the Baptist Chapel to about 100 people on the same subjects as at the two previous centres. Afterwards gave demonstration on pruning and manuring coffee, and on budding oranges. This would have been continued to a greater length but for the rain which put a stop to it after about an hour.

Thursday, 20th.—Lectured and demonstrated at Stepney. Only a small audience was present here, but those who were present were people who attended on the occasion of my previous visit to this place, and who had made use of my suggestions, and were keen to see further demonstrations.

Friday. 21st.—Lectured and demonstrated at Linton Park. This is a remarkably fertile district only as yet partially settled. This is one of the finest districts for settlers that I have ever seen. The people were particularly interested in the budding, as the district is full of young sour orange trees, which they are anxious to turn into grape fruit.

Saturday, 22nd.—Visited the cultivation of Mr. Moulton Barrett, of Stewart Town. Mr. Barrett is growing grafts and was very anxious to get my advice on them, he had also an acre of excellent Irish potatoes.

Monday, 24th.—Lectured and demonstrated at Lower Buxton. The people were quite enthusiastic over my coming. Some of them have been successful with the budding, others have treated their decaying coffee with lime and seen the beneficial results. I was unable to visit the fields where this had been done as it rained heavily all the afternoon; the demonstrations were given before the lecture while the people were gathering.

Tuesday, 25th.—Lectured and demonstrated at Grateful Hall. Here again the people were quite interested. One man after my last visit had treated three of his poor drooping coffee trees with lime. These trees I went and saw with all the people who had attended the lecture, and there those three trees stood out in bold relief through the coffee walk, being vigorous, covered with young growths with dark healthy green leaves,—the untreated trees being still yellow and sickly-

looking with scarcely any young growths on them. So impressed is the man with the good of the lime that he has burnt a large kiln solely for the purpose of manuring the rest of the coffee.

The people in this district are anxious to try other cultures, and I advised them to try grapes, pine-apples and tobacco and gave them instructions how to grow them.

Wednesday, 26th.—Lectured at Sturge Town. This is a new centre. The people have excellent land, yet make very little use of it. They were however quite interested and anxious to gain information,—one man remarking that he thought it a great pity that the Government had not thought of sending lecturers round thirty years ago.

As a result of my visit I may mention that the following plants have been ordered solely by small settlers through the Rev. Geo. Henderson.

Stepney.

62 Kola.
3 Nutmegs.

Grateful Hill.

16 Ripley Pines.
16 Grape Vines.
6 Kola.
12 Chocolate.
2 Cocoa.

Sturge Town.

24 Pines.
18 Kola.
30 Nutmegs.

Lower Buxton.

12 Nutmegs.
6 Kola.
6 Grapes.
4 Cocoa Pods.

Thursday 27th.—Visited Rev. J. P. Hall, relative to plants required for the Brown's Town Church Yard. Visited Hon. Dr. Johnston, and discussed with him the prospects of introducing new cultures among the people of St. Anns. The conclusion arrived at being that it would be better to try to get the people to improve their present cultures rather than risk introducing cultures which might turn out failures; the exception being articles which could be used as food by the peasantry about which there could be little risk.

Visited Mr. Braham's coffee cultivation at Moneague, discussing pruning, shading and manuring.

Friday 28th.—Visited the orange grove of Mr. Conran, at Woodfield, Mr. Conran has planted very large groves in the most approved style wholly with budded stock.

Westmoreland, St. James and Hanover.

Monday, 27th Sept.—Lectured in the School Room at Bruce Hall (Retrieve Bridge) to an appreciative audience, nearly all of whom are land owners, chiefly on the tillage of the soil, draining, etc., explaining how the general principles laid down affect all crops.

The Rev. P. Williams, of Bethel Town, Vice-President of the Lambs River Branch of the Jamaica Agricultural Society, presided. The

audience listened most attentively to a lecture of an hour and ten minutes, expressed themselves highly pleased thereat, and as a practical way of showing their interest asked a series of questions bearing on the different points whieh occupied nearly another hour in answering. Nothing can better indicate the interest or the grasp an audience has on a subject than the nature of the questions afterwards asked.

Tuesday 28th.—Lectured in the School Room at Lambs River. The audience consisted largely of members of the Lambs River Branch of the Jamaica Agricultural Society,—the subjects treated were the same as at Bruce Hall.

The President of the Lambs River Branch of the Agricultural Society, J. R. Williams, Esq., Inspector of Schools, presided. Archdeacon Ramson, A. Farewell, Esq., and G. A. Douet, Esq., were also present. Mr. Douet brought samples of growing and manufactured Ramie. Heearnestly advised every one to plant some, so that they might gain some experience of the plant at once, which would prevent their wasting time in the event of the plant becoming a remunerative crop.

Mr. Douet also brought samples of Farine and explained how it was manufactured.

Wednesday 29th.—Lectured in the School Room at Bethel Town. The subjects dealt with being practically the same as at the two previous meetings. J. R. Williams, Esq., again presided. The Rev. P. Williams and Rev E. J. Hewitt were also present. These gentlemen expressed the liveliest approval of the lecture, and of the work of the Government in instituting such lectures for the people.

At all the places the people expressed their gratitude for the Lectures, and the hope that I would return in the near future to deliver others.

St. Ann.

I beg to report that in accordance with instructions received from you, I visited and gave lectures and demonstrations on the cultivation of Tobacco, Coffee, Cocoa and other products at the centres and on the dates given below, illustrating by actual demonstration the proper way to fork and treat soil when planting out crops and taking steps to ensure the proper condition of the soil for the after well-being ot the plants.

The demonstrations were badly attended save at Ramble Pen, The local organizers of these meetings should take the greatest care to be very explicit as to dates, etc., or the meetings in point of numbers are doomed to be a failure. A really good gathering was present at Ramble, fully 60 men being present. The lecture in the evening at Claremont was unfortunately spoiled by rain.

The following were the centres visited :—

February 1st, Bensonton.
" 2nd, Ramble
" 2nd, Claremont
" 3rd Walkers Wood.

Manchester, Westmoreland, Hanover, St. James Trelawney and St. Ann.

Visited Grape Farm, and prepared cuttings. The Grape Farm is looking well, the vines have not yet commenced to grow to any appre-

ciable extent, but they look nice and green and should make good progress as soon as the proper season arrives. People are still planting grapes extensively. Plenty of good bunches of black grapes are ripening. For want of thinning they are of only ordinary quality, but with a little care and skilled attention they might easily be made first-class. I sent up seven baskets full to the Secretary of the Agricultural Society.

I have given directions for the whole of the cleaned land at the Grape Farm to be planted with grape cuttings. I think the slight shade of the various crops now growing will prove beneficial to the young vines; in such a hot place it certainly will not be harmful.

The remainder of the land should be cleaned and covered ready for planting in the spring and and autumn. I do not recommend that anything more than a very small trial of say three plants of any variety other than Muscats be made. The common black is the best black without a doubt for present purposes. The Muscats, however, are so superior in flavour, that a good trial of these should be made. There is reason to believe that they will thrive, as some plants of Mr. Shaw's are doing well; one plant which he got from Hope in May last year, has made a growth of 30 feet. Some plants of Muscat Hamburgh have done fairly well also, but the other varieties do not appear likely to thrive.

Wednesday Feby. 16th—Visited Carmel, lectured and demonstrated there on coffee and oranges and on tobacco-growing to about 70 or 80 men and a number of women.

Tuesday, Feb. 22nd.—St. Ann's Bay. Demonstrated on Mr. Nunes' vines on pruning, and illustrated the proper treatment of them by means of the material found there. About 15 people attended, the number would have been double as Mr. Nunes had taken the trouble to properly advertise my coming, but unfortunately influenza was raging in St. Ann's Bay.

Manchester.

Tuesday, March 1st, 1898.—Lectured at the Court House to a fairly good meeting of about 30 men on cultivation, management of soils, draining, manuring, liming, &c., and afterwards gave an ocular demonstration thereon, also on pruning coffee.

Wednesday, March 2nd.—Lectured and demonstrated at Devon on the same topics with the addition of tobacco, about 30 people being present.

Friday, March 4th—Lectured and demonstrated at Walderston to about 60 people who seemed very intelligent and very interested.

General Remarks.

I was very pleased to see the good quality of the coffee grown about Christiana, but grieved to see the way in which the people spoilt it in curing.

I was much pleased to see the good result of an experiment in forking and manuring land for ginger.

A piece of land which had formerly been planted with ginger and consequently was now looked upon as worthless, worn out, &c. had been forked and manured simply with rotten cane trash. With this simple treatment it had produced excellent ginger, thus showing that ginger can be grown on land for a term of years.

St. Thomas.

Tuesday, March 8th.—Lectured in the Court House at Morant Bay to about 50 people on the management of soils, manuring, &c., also on cocoa, tobacco, coffee, oranges and grapes.

Afterwards demonstrated on the budding of oranges and pruning of coffee and cocoa.

Thursday, March 10th.—Whitehall. Lectured in the School-room to a room full, on coffee, oranges, tobacco and cocoa, and afterwards demonstrated on budding of oranges and pruning coffee and cocoa.

Friday, March 11th.—Johnstown. Lectured in the School-room to an audience of about 25 men and a number of women and the bigger School children, the subject being the same as the day before.

Saturday, March 12th.—Visited Dr. Neyland's cocoa cultivation at Bachelor's Hall, and visited numerous people's cultivations on the road, gave advice to Mr. Stewart in particular regarding his grapes, peaches, coffee and oranges.

Monday, March 14th.—Lectured in the School-room at Thornton. While dealing with the crops fit for the locality, particular stress was laid on the way in which the people waste the land, and yet are dissatisfied that they cannot get more.

Tuesday, March 15th.—Lectured at Chigoe-foot Market to a good audience of 50 or 60 adults and about a dozen of the biggest boys from the Seaforth School, dealing with tobacco, oranges, coffee and grapes; the soil here is light and sandy and should grow, I think, grapes of a good quality.

Wednesday, March 16th.—Lectured at the Wilmington School-room to a house full of people.

The large attendance was doubtless due to energy, and the interest taken in the people by the Rector of Morant Bay.

The people hereabouts are very land-greedy; many think an acre of land not worth bothering with and because they cannot become the possessors of a large tract they simply sit and grumble. I therefore devoted a good deal of time after lecturing on tobacco, oranges, treatment of ground provisions, and cocoa, to show what might be done with an acre of land and I think I succeeded in impressing a few of them with the idea that an acre of land would really produce something if properly cultivated.

St. James and Hanover.

Wednesday, March 30th.—Lectured and demonstrated at Retrieve School on cultivation of coffee, oranges, ginger, and tobacco to about 30 men besides women and the biggest School-children. Also demonstrated with the aid of a skilled labourer from the gardens the use of the ordinary digging and Assam forks, and on draining the land. This is a most favourable locality for such a demonstration, the land being rich but heavy and in some instances badly drained.

Thursday, March 31st.—Lectured at the Mt. Hermon School-room to about 30 men, chiefly members of the Lamb's River branch of the Agricultural Society, the subjects dealt with being the same as at Retrieve. The land in the immediate vicinity of Mt. Hermon was not favourable to a demonstration of implements, but many of the audience were from surrounding districts where such implements would be ex-

tremely useful and were much interested in them, the Assam forks especially appealing to their fancy.

HERBARIUM & LIBRARY.

Numerous plants and specimens have been sent up to the Herbarium for information respecting their names, their value, properties, &c.

A merchant, perhaps, requires a certain product, a sample of which has been received from London or New York, and he enquires what it is, where it may be obtained, in what quantities, &c. Whether the product would pay to export or not, or whether it is even known in Jamaica; the examination and research consume a considerable amount of time.—I may instance the West India Dragons Blood, of which an analysis was made by the late Prof. Trimble in Philadelphia, who reported that it would be of value as a medicinal kino, if found in sufficient quantities. A perfume-maker in England writes about an extract from a native plant for use in perfumery. A pen-keeper again, finds some of his cattle dying, suspects that they have been poisoned by eating a certain plant, and submits it for examination. Another is troubled in his pastures with a weed, and asks whether it is hurtful to cattle, or exhausting to the soil. Another notices a new grass, which on examination turns out to be a native of Australia, and of considerable value as fodder. A planter comes across a tree on his estate, bearing fruit said to be edible, and asks if it is so. Another finds on a newly-purchased estate an avenue of trees, sends up specimens, and enquires about the value of the tree.

Several correspondents have forwarded specimens of diseased plants, wanting to know their nature, and whether there are remedies for the pests. Others who take an interest in botany, wish for the scientific names of plants, especially of examples of our native flora.

The Herbarium collections are continually being increased by additions, and Mr. William Harris, Supt. of the Hill Gardens, is as assiduous as ever in collecting.

Rare Ferns.—Several have been found, but the three following may be mentioned :—

Lonchitis aurita, Linn.—Mr. G. S. Jenman writes—"Plumier gathered the plant in Martinique about 220 years ago, and it was not re-discovered till 1880, when Mr. Nock found a single small plant below John Crow Peak in Jamaica. Nock only gathered two specimens, one of which is at Kew, and the other was mislaid or lost. He was unable to find his plant again, although he searched repeatedly for it."

This plant was re-discovered by Mr. Harris, in another locality, in the early part of 1898.

Polypodium jubæforme, Kaulf.—Mr. Jenman writes–"Gathered by Swartz, whose specimen is in the British Museum, but collectors since have not re-discovered it. I failed to find it, although I searched far and wide for it." Re-discovered by Mr. Harris in 1898.

Anemia mandiocana, Radd.—Mr. Jenman in speaking of the habitat of this plant says :—"Jamaica, according to Grisebach, who correctly describes it, but I have only seen Brazilian specimens."

Collected by Mr. Harris in 1898.

Insect pests have become exceedingly troublesome in the destruction of dried specimens since the Herbarium has been moved to the warmer climate of Hope Gardens; and more time and labour are consequently required than formerly in the preservation of the dried plants.

Books have been added from time to time to the Library, that are necessary in the determination of plants, or that put forth new truths in the science of agriculture and their application in practice, or summarise experimental scientific work that has been carried on invarious parts of the world. Without a properly equipped Library, the Department would quickly fall behind in a knowledge of the wonderful advances that are continually being made in the science of plant life.

The vote is spent partly on books, partly on periodicals for the Library, partly on periodicals (Kew Bulletin and Gardening Papers) for the Superintendents' Offices, and partly on binding.

The exchange of periodicals effected by sending the Bulletin to foreign correspondents, has enriched the Library shelves with a mass of literature, which deals with current questions about agriculture and botany, and gives details of actual work and experiments in progress elsewhere.

In this connection I wish especially to call attention to the Bulletins issued by the Experiment Stations of the United States, which are very kindly contributed by the Directors. The value of these Bulletins is greatly increased by the publication of an Index. "For some time the office of Experiment Stations has been engaged in the preparation of a subject index of the literature of Agricultural experiment stations and kindred institutions. The general plan on which the index is constructed may be briefly outlined as follows :—

"The subjects with which Agricultural Science deals have been grouped under a limited number of general topics. These topics have been divided and sub-divided only so far as seemed necessary to facilitate references to the individual entries of the index. As the work of the stations reaches out in many directions into the domain of pure as distinguished from applied science, a section of the index has been set apart for entries relating to the general principles of the various sciences which lie at the foundation of experimental investigations in agriculture. This affords a wide opportunity for the extension of the index by individual students for their own special purposes.

"The index is printed on cards of a standard library size. The divisions and sub-divisions are arranged on a decimal system and are plainly indicated by the use of division cards of different colours.

"Each index card contains the title of an article, the name of its author, a reference to the publication in which it appeared, and to the Experiment Station Record, and a condensed statement of its contents. At the upper right hand corner of the card is a number indicating under what head the card should be placed in the index."

This index is in the Library. By means of it students, wishing to see the latest information on any particular subject worked out by the Experiment Stations, can without loss of time, turn up the Bulletins referring thereto.

Industrial School.

The Industrial School has been conducted on former lines. I am anxious that some means may be adopted whereby it is possible to ad-

mit others who would pay for diet, clothing, etc., and so not cause any extra expense to the Institution. It seems to me that the only way to start the plan would be to take some few of the best of those who pass the Pupil Teachers' Examination, admit them to the school, and charge them nothing for their board and education. When a beginning was once made in this way, and the standing of the School thereby raised, parents would probably be found willing to pay a certain sum for their boys at the School. But the free apprenticeship system should precede that of payment. If necessary the Gardens Department would refund the Treasury the amount of these apprenticeships, as the labour of picked boys would be of equal value to the Gardens. It may be said that money is not voted by the Legislature for the purpose of providing such apprenticeships, but if part of the sum voted for labour were spent in this way, and the value for that received in labour by the Gardens, neither the Government nor the Department would suffer any loss, and the country would gain in the training given to a few boys. The Report of Mr. Hopwood, the Master in charge, is published separately.

APPRENTICES.

Boys from West Coast.—The Colonies of the West Coast of Africa have adopted a general scheme whereby picked boys shall be sent for training in horticulture and economic agriculture, first to Jamaica and afterwards to Kew Gardens.

This scheme is due to the success that has attended the experiment initiated by the then Governor Sir A. Moloney, of sending in 1890 two native lads from Lagos to be trained as Gardeners at the Jamaica and Kew Gardens. After spending two years and a half in Jamaica, they were attached to Kew Gardens for some months, and now are in charge of branch Botanic Stations in Lagos, growing and preparing agricultural products, and giving instruction.

The following are the Regulations under which boys are apprenticed at the Gold Coast:—

1. "Two apprenticeships are offered by the Government for the purpose of teaching to natives of the Gold Coast Colony the details of horticulture and economic botany in tropical countries.
2. "Candidates must fulfil the following conditions as to age, parentage, residence, scholarship and physical fitness:—

Conditions.

(a.) "*Age.*—A candidate's age must be not less than 16 and and not more than 20 years on the first day of the year in which the apprenticeship is offered.

(b.) "*Parentage.*—The parents of the candidates must be, or if dead, must have been, natives of the Gold Coast Colony, or resident in the Colony for not less than five years before the first day of the year in which the apprenticeship is offered.

(c.) "*Residence.*—The candidate himself must be a resident in the Gold Coast Colony.

(d.) "*Qualifications.*—A candidate will be required to pass an examination in English equal to that required for Standard VI. in the following subjects, Reading, Writing,

Arithmetic, or must produce other such evidence as shall satisfy the Government of his general fitness and ability in English.

(e.) *Physical Fitness.*—" Each selected candidate must produce a certificate by the proper Medical Officer of his physical fitness.

3. " Selected candidates will be apprenticed to the business of tropical horticulture and economic botany and agriculture.
4. " Each apprentice will be required to sign indentures with two sureties in the sum of £250 binding him as an apprentice for four years, and further binding him after the completion of his apprenticeship to serve the Government of the Gold Coast Colony at any botanical station or experimental farm or garden for 7 years as a garden assistant under the regulations in force for the time being, as to pay, promotion and leave
5. " An apprentice will be required to provide himself at his own expense and to renew from time to time as required, with the following outfit . . . . .
6. " Apprentices will be sent to Jamaica to undergo training at the Hope Gardens and afterwards at the Royal Gardens, Kew. A second class passage will be provided by the Government of the Gold Coast.
7. " During the period of their residence in Jamaica or at Kew, they will be required to attend diligently to the work allotted to them, and to obey all lawful commands of their superior officers. Half yearly reports of their conduct and progress will be obtained from the Government of Jamaica and the Director of the Royal Gardens, Kew.
8. " A sum of £   a year will be allowed for the board, lodging and training of each apprentice during his training, and the proper authority will decide where apprentices shall board and what proportion of the allowance shall be paid for board and lodging, and what sum shall be allowed for pocket money and maintenance of stock of clothing subject to good behaviour. Necessary supplies of clothing in Jamaica will be charged as an advance against the first year's salary of the apprentice on his return to the Colony. . .
10. " Upon the expiration of the course of training and upon the receipt of a satisfactory certificate of conduct and proved ability from the authorities at Kew, the apprentice will be sent back to the Gold Coast Colony, a second class passage being provided by the Government.
11. " If in consequence of idleness, disobedience, insubordination or other misconduct of an apprentice, the Government of Jamaica shall decide that he is unfit to remain at a Government establishment to be trained, he may be sent back to the Colony at any time, and in that case the cost of his passage both ways, and the aggregate sum paid for his maintenance under clause 8 above will be recoverd from his sureties.
12. " Upon his return to the Gold Coast Colony with a favourable report and certificate of capacity from the authorities at Kew,

an apprentice will be entitled to be appointed to be a garden assistant at a botanical station or experimental farm or garden of the Gold Coast Colony on a salary of £50 a year rising by annual increments to £80 a year.

13. "His further progress will depend upon his ability and trustworthiness, and there is no reason why he should not rise to be an Assistant Curator on £100—£150 a year."

Under this scheme two apprentices are under preliminary training under the Curator of the botanic station of the Gold Coast, and if favourably reported on, will proced to Jamaica.

Hope Gardens.

The following report is by the Superintendent, Mr. Wm. Cradwick :—

Economic Plants :—Nutmegs. The tree which bore such a heavy crop in 1895-96, bore only a few fruits this year; this tree produces small round fruits. One of the trees producing the large elliptical fruits has a much heavier crop, as near as can be estimated, about 500 fruits, but they are not quite so fine as last year. The trees on the whole look very well indeed, which proves after so dry a year as we have just passed through that the nutmeg is a tree which can be cultivated successfully even with only partial irrigation.

Unsuccessful attempts have been made to bud nutmegs. but inarching will now be tried.

Liberian Coffee. The old trees of Liberian Coffee have improved a good deal during this year, I can scarcely give a reason, except that the improvement is the result of two year's careful cultivation watering and manuring.

The young plantation of Liberian Coffee has also greatly improved, most of the trees look nice and green and many have flowered. Scale insects are a great pest on these plants however, and it is necessary to be continually spraying some of the trees. Some of the trees are now nearly six feet high and have good strong laterals, some of the trees will be topped and some allowed to grow naturally.

Arabian Coffee. The small plantation of Arabian Coffee now two and a half years old is still thriving, some of the trees yielded as much as 6lbs. of coffee and there is a promise of a large crop this year. The trees are in many cases putting on secondary branches, and in every way look very strong and vigorous, at present they are superior to the Liberian with identical treatment. Another planting of trees has been made numbering 52 plants.

Abbeokuta Coffee. This still looks as healthy as ever, except one or two trees which have been troubled with scale insects in the same way as the Liberian: it is just commencing to flower.

Stenophylla Coffee. These plants have improved in appearance and look fairly well, one tree began to flower abut the middle of February. Another plantation of 21 trees has been made further down the economic ground.

Mocho Coffee, so called. The plants of the supposed Mocho Coffee have grown fairly well, but it is now apparent that there are two varieties from the seeds we received, one apparently ordinary Arabian, the other a much more upright growing tree with smaller leaves which are also more upright than those of the ordinary Arabian.

Cocoa. Several trees of worthless varieties have been destroyed and we have now none but Red Caraccas, Red Forastero, Yellow Forastero the true Criollo and good hybrids of these.

The Criollo tree is a very fine one and produces especially on the main stem some splendid pods A tree of Forastero in the Nursery also shows what can be done by good cultivation and plenty of water. I propose to increase the number of Criollo trees and of the best types of other varieties

The plant of Theobroma bicolor is now about 5 feet high, it has not branched; 6 more trees of this species have been planted out.

Sugar Canes. Nearly all the plant canes were analysed by the late Island Chemist, but owing to his death very little has been done with the ratoons. The results of the analysis have been published in the Bulletin for October and November, 1897.

Owing to the large demand for tops of No. 95 canes, the area under this variety has not been increased so much as I had hoped it would have been. During the unusually heavy "seasons" in October a large quantity of tops which had just been planted were washed away in the floods. But we shall be able to supply about 10,0 0 tops this year and four times that quantity next year besides increasing our own stock.

The land which is available for Cane cultivation at Hope has been under that cultivation for so long that it is absolutely necessary now to cultivate in an expensive manner. When replanting, trenches 2 feet wide and 2 feet deep are dug, the top soil is returned to the bottom thoroughly manured and the balance of the trench filled up with the lower strata of soil. Irrigation has to be strictly attended to, and the plants of course kept clean. Manure is an expensive item ; we have a stock of sheep manure purchased for our future planting, and manure is being continually carted from Gordon Town. Nos. 115, 116, 95, 74 and Po-a-ole are all proving themselves good ratooning canes.

Grape Vines. Vines were pruned the first week in October with the object of getting ripe fruit in February, but owing to Yellow Fever breaking out at the Gardens the vines did not get the attention they should. The varieties pruned were Black Hamburgh and Black Alicante. The Hamburgh always required a greal deal of attention with regard to thinning, this they did not get this year for the reason stated. Mildew also infested them badly, consequently only one or two bunches came through and these were inferior. It is a great pity that this grape is so troublesome to grow for its exquisite flavour puts it far ahead of the common black grapes so much grown in Jamaica.

Lack too of thinning went a long way toward spoiling the Alicantes, but very little mildew appeared on this variety. I hope to try this variety again next year under more favourable circumstances.

Muscat of Alexandria. There is no doubt that this is the most desirable grape for Jamaica, being a strong, hardy grape, which does not require much thinning, and its flavour has no equal. Unfortunately we had very few plants of this variety, but a large quantity of cuttings have been imported from England.

Raisin de Calabre. This variety also did extremely well at Hope, and is a desirable grape, but requires a good deal of thinning.

The large, black grape from King's House, probably the same variety

so common on the Savannah's, grew vigorously, bore fairly well, but it does not ripen up evenly.

Black Hamburgh and Black Alicante ripened up nicely during the summer crop, but they require a very great deal of thinning.

All the varieties received from Chiswick last year have grown well, but of course have not fruited. Some may do so this year.

The American varieties are, in my opinion, quite unsuited for the tropics, they have grown very badly. A gentleman in Kingston tells me that he has had some of these for over seven years and they have done nothing.

A new arbour 203¼ yds long, 12 ft. wide, has been erected and looks well. I would recommend any one wishing to erect one to imitate it

Pines. As stated in my Report for last year, particular attention is being paid to selecting the best variety of Ripley Pines. I also stated that the quality of the future fruits of these plants could be largely determined by the markings of the leaf. The plants have been kept under strict observation with a view to determine what difference might be made by selection and cultivation. Plants have been propagated by slips only of fifty-five plants, thus raised from plants with correct markings which are now about a year or nine months old. Many of them will fruit this year when fuller information will be procurable. Twenty-three have developed bad markings, i.e. red marks on outside of leaves; thirty-two plants have the correct markings. Of eleven plants raised from parents with markings on the outside of the leaf as well as the centre, 10 have developed bad marks, one only developing correct marks. Of 17 plants raised from parents with markings on the outside of the leaf, only 15 have developed bad marks and 2 have leaves devoid of colour. Another curious thing noted, is that in the two latter instances, in same cases, the main stem has failed to develop, assuming a twisted form, and developing side shoots only, so that no fruits will appear on these plants this year. Five plants of the 11 mentioned as having markings, on the outside of the leaf as well as in the centre, have degenerated in this way, and 3 out of the batch of 17, none of the plants raised from parents with correct markings have degenerated in this way.

Artificial manure for Pine Apples has proved of the greatest value, increasing the vigour of the plants wonderfully, and adding nearly 1½ lbs. to the size of the fruit, as well as hastening their ripening by fully two weeks. A trial to determine the relative merits of slips or suckers is also being carried out.

Oranges, &c., The old budded trees by the glass house continue to look well, but are not fruiting much.

The grove of budded plants is doing well on the whole, except where sweet orange has been used as a stock, out of these 7 are dead and 8 are looking poorly. I am afraid that this is not a good stock for Hope.

The 18 Tangierenes on rough lemons are growing well.

The 18 sweet oranges on rough lemon stock are all growing and look healthy.

The 19 sweet oranges on sour oranges have all grown well with one exception which has gummed a little, but will, I think, recover.

Of the 6 Imperial Lemons on sweet orange stocks, two have died, 3 are looking fairly well, one has died back but is springing again.

Of the 10 Imperial Lemons on Rough Lemons, 3 have died, the others, with one exception, are looking extremely well.

Of the 5 Grape Fruit, Castleton varieties, on Rough Lemons, one has died, the others look well.

Of the 6 Grape Fruits, Castleton variety, on sweet orange stocks, 3 have died, two look poorly, the remaining one looking very well.

Of the 12 Grape Fruit on Rough Lemon stocks all are growing exceedingly well.

The 4 Melrose shaddocks on Rough Lemons are all growing very well.

Of the 32 Navel Oranges on Rough Lemons, one has died, the rest look now fairly well, but many of these have gummed considerably, not so much at the collar, but in the branches, the formula recommended in the Bulletin (Sept. 1887) has been tried for the gumming and seems to be very effective.

The grove has been extended by 6 Navel oranges, 14 Grape Fruits, all on sour orange stocks.

Mangoes.—The inarching of Bombay mangoes during the past year has been very successful, chiefly owing to the raising of better kinds of stocks after the methods mentioned in last year's Report. We have been able for the first time to keep the supply of grafted plants equal to the demand which is still small as these exquisite fruits are not well known, and we have a stock on hand of about 50 grafted plants. Seeds of Mexican mangoes, supposed to be something very superior, have been received and a nice stock of plants raised.

Several plants of mangoes imported some years ago from Martinique have also fruited, one very freely, this is a fine fibreless mango with a yellow skin and of good flavour, but not so good as our variety of the Governor Grant Bombay mangoes, the Nagapoury.

Ramie.—The plantation has been kept clean but not extended.

Ginger.—One acre of land was thoroughly forked up and thrown into beds and planted with ginger, 1,000 feet of ¾ inch galvanized iron pipes with fittings, etc., being laid down to enable us to water it, with the object of testing various manures. The result has been disappointing and it has been decided to leave them in the ground until next year.

Canaigre.—12 roots of Canaigre were planted and yielded a little more than the weight put. The crop was planted out near the ginger but unfortunately all but three plants were washed away during the October floods, these plants look very much better than they did last year.

Tobacco.—The first planting of tobacco suffered severely from the October floods but in spite of that, we have been very successful and shall have seeds in abundance for distribution. The main crop has been raised from Cuban seeds, but we are told by many Cubans that our plants are better than the finest grown in Cuba. We have also a square chain of land in Sumatra tobacco which has also grown well and we shall have an abundance of seeds of this variety. Besides these well known varieties we have 5 other varieties.

The object is primarily to raise seeds of Havana and Sumatra to-

bacco for distribution, secondarily to make a trial of the other varieties. With regard to raising plants for seed we are careful to destroy any weakly plants so that the whole of our seeds are raised from strong healthy plants only.

Logwood.—A plantation 1 chain wide and 3½ chains long of British Honduras logwood has been planted.

Rubber.—The Hevea rubber, now two years old, are from 10 to 15 feet high and are looking very healthy. We have also another plantation of 126 Castilloa elastica and they are looking fairly well.

Figs.—The fig cuttings received from Chiswick have grown nicely and are commencing to fruit.

Correspondence.—The number of letters despatched is 4,598.
" " " received " 3,346.

Buildings.—We are still badly off for buildings and I hope that during the coming year we shall be able to put them up at the expense of the Gardens, although this is a heavy charge on our finances. We want a new stable and a packing shed. Few people realize what the nursery business is at Hope

A shelter for visitors is also wanted and will be more so when the Electric Car runs up to Hope. A new glass house is badly needed for seeds.

Roads.—Fifty-four chains of road have been repaired some twice and thrice over, owing to the heavy October floods.

Fences.—Sixteen chains of new fence have been made by the side of the road over the conduit and fifty-one thoroughly repaired.

28 chains of new fence have been made elsewhere.

A new iron gate has replaced the old lumbering wooden one at the entrance from the Hope Road.

The *Ornamental Section* of the gardens has been kept in good order, the only plant calling for any special comment this year being the "Double Poinsettia."

A Rockery, 2 chains long, four feet in width, has been made to accommodate succulent plants

The following plants have been planted out in their proper places:—

2 Nephelium Litchi.
1 Shaddock.
1 Adenanthera pavonina.
1 Eugenia malaccensis.
1 Mesua ferrea.
1 Gynocardia odorata.
1 Caesalpinia sappan.
1 Barringtonia speciosa.
1 Acalypha Wilkesiana.
1 Licula elegans.
1 Licuala spinosa.
2 Livistona chinensis.
2 Raphis flabelliformis.

Hope Industrial School.—The teaching has been the same as last year and the practical work the same.

Nursery.—To meet the increased demand for economic and ornamental plants, shade trees etc., it has been found necessary to still

further extend the nursery, covering at present a little over 3 acres of ground.

A large quantity of seeds have been wasted during the past year owing to inadequate glass accommodation; seedlings need shelter until strong enough to bear the battering which they get during heavy rains.

The Orchids have been highly appreciated by the Public, their gay appearance when interspersed with ferns and the comparative ease with which they can be successfully grown, provided they are placed at once under the right conditions have induced several gentlemen in the Island to make collections.

The Divi Divi walk continues to be an ideal place for the Orchids during the growing season, as it affords many different positions with varying degrees of heat, moisture, light, and shade to meet the requirements of the different species,

A large number of Dendrobium phalaenopsis var. Schroederiana, and Dendrobium formosum giganteum, were received from Messrs. Sander & Co., St. Albans, England. These have turned out quite a success, nearly every plant flowering and lasting in flower for fully three months.

Several of the new varieties of Begonia rex from Sander, promise to become as well established as the older varieties, the following new varieties will shortly be ready for propagating:—

Begonia rex vars. Lebrun, Mrs. W. Elphenstone, Decorator, White Collarette, Hatfield Gem. Among the plants received from Kew and Sander & Co., may be mentioned Maranta Sanderiana, Dracaena Sanderiana, Ficus Canoni, Alloplectus Lynchii, and Graptophyllum pictum, as being notable acquisitions in the way of ornamental pot plants.

The Palms and other plants in pots have received the necessary attention and are looking well, and the usual general nursery work has been carried on with ever increasing pressure.

Plants Distributed.

Sold.

Economic Plants:—

Kola	24,475
Coffee	11,706
Nutmegs	2,297
Oranges	34,341
Grape Fruit	1,976
Rubber	635
Ramie	24,520
Cocoa	2,177
Tangierine	1,200
Grape Vines	724
Pine Suckers	2,330
Canetops	9,024
Miscellaneous Fruit and Economic Plants ...	5,371
	120,776
Ornamental Plants	14,229

Free Grants.

Economic Plants :—

Miscellaneous (including Timber and shade trees)	10,951
Ramie roots	16,024
Ornamental Plants	4,214
Total number of Economic Plants Distributed	147,751
" " " Ornamental " " ...	18,443
Total number of Plants Distributed ...	166,194
Eucalypti Plants distributed Free ...	2,281
	168,475

Visitors.

The number of Visitors to the gardens were from March 1st, 1897, to March 31st, 1898, 18,071.

The elevation of the garden is 700 feet above sea-level.

The average annual mean temperature is 71.6° F., and the average annual rainfall 52.18 inches for seventeen years. The amount of rain that fell during the year was 62.39 inches. The wettest months were May, September, October, and the driest were December, January and March. The mean temperature for the year was 77.3° F. The Meteorological Tables for the different months are given on page 317.

Castleton Gardens.

The following Report is by Mr. William Thompson, Superintendent :—

The walks have received the usual attention, and have been kept free from weeds, etc.. The heavy rains in the Autumn, caused extra work in replacing soil and gravel that had been washed off. The old stone gutters have been dug out and replaced in concrete.

New fencing has been erected several chains in length, and the old fencing has been repaired. The fence on each side of the main road is in need of new posts. This will be expensive, as good hard wood posts are needed.

The lawns, verges, grass-pieces and pastures have received the usual attention and are in good condition. Most of the narrow turf verges have been widened.

The beds and borders of mixed plants have had the soil well forked and manured. Several shrubs have been transplanted and other plants, trees and climbers have been pruned. Many border plants were planted out. The plan has been adopted of putting into separate beds collections of such plants as Dracaenas, Ixoras, Hibiscus, etc.

Two royal palms, Oreodoxa regia, have been planted at each side the main entrance; two plants of Lagerstroemia Flos-reginae have been planted on two conspicuous hills on the north west side of the garden, also a royal palm on the lawn in front of the office in commemoration of Her Majesty's Jubilee of 1897.

A number of young trees, palms, climbers and shrubs have been planted, most of them being new to the garden :—see list of plants planted out.

Several tree-ferns have been planted out in different parts of the garden. A number of young trees of kinds in the garden already, that grow very large, have been planted in the outer parts of the

garden with a view to removing the old trees in the future, and so giving more room in the inner parts of the garden.

The smaller trees of the Amherstia have made good growth and bloomed freely. Thirty young Amherstia have been raised from seed and sent out; also seedling plants of Mesua ferrea, Jacaranda filicifolia and Colvillea racemosa.

The old Rose-garden has been reformed. Half the small walks have been closed, the remaining walks have been made nine feet wide. The Arches over the walks have been widened three feet. The beds have been trenched, manured, and some fresh soil added, and the plants transplanted.

Two beds of roses have been planted in other parts of the garden, and some on the open lawn on the economic side of the garden. This is the land cleared from bamboo two years ago, with the result that it is the best place in the garden for roses. There are enough rose plants to provide all the rose wood needed for propagating; this year four thousand rose plants have been propagated from wood grown at Castleton.

Large labels have been attached to the different kinds of plants in the nursery and to all the large trees in the garden.

The nursery has been still more enlarged this year, by the addition of beds for seeds and cuttings. The nursery is now large enough to turn out at least 10,000 plants in pots and five times as many from beds.

Liberian Coffee plants have been given away in large numbers to settlers.

I wish to point out that it costs much more to have to keep the same plants in the nursery all the year through, than it would cost to grow twice the number, if the plants could be sent out as soon as they are in a fit condition to go away.

We have 4,000 rose plants in stock; this is, I believe, the largest number of rose plants that has been in the nursery at one time.

I have been able this year to begin to work up the collection of plants. One shed 40 feet long is filled with about 100 different kinds of Jamaica ferns. Another shed 40 feet long is filled with such plants as Begonias, Caladiums, Alocasias, Authuriums, Ferns, &c.

There is now a large stock of Ornamental pot plants in hand for sale. Another plant shed has been erected. All the other plant sheds have been repainted.

The orchid shed had been removed from the upper part of the Garden down to the nursery. The imported Orchids have made remarkable growth and a large number have flowered. The Cattleyas, Vanda tricolor, Dendrobiums and Calanthes gave a good show of bloom for months. The garden is being well stocked with native Orchids, and Broughtonias. Epidendrums, Phaius and Oncidiums have flowered well.

We have now six plant sheds in all, and there is still need for more.

A large number of Orchid baskets have been made and all Orchids repotted that needed it.

A new thatched-roof has been put on the old fern house. I have added several windows to this house, but I have come to the conclusion that it will never be any good for growing ferns in, unless the

roof is raised about three feet. The ferns grow much better in the open plant sheds; in fact they grow as well as can be wished for. The old fern house is available for visitors to shelter in. A new open thatched roof house 36 feet by 20 feet has been erected on the economic side of the garden for the better accommodation of Visitors; it has also been fitted with benches and moveable tables. The rest of the benches and tables about the garden have been repaired and painted as required.

The gutter that ran along side the Liberian Coffee field has been filled in with large stones.

The garden is very much in need of some cement or iron tanks for the nursery.

The tanks that were built three years ago by the Public Works Department have been invaluable. This year, as last year, the rainfall has been only one-third of what we generally get for the first three months in the year. Although the tanks have helped us to tide over the dry season, something should be done to buy the land that covers the head of the springs. At the present time this land, about ten acres, is being cleared of all its vegetation, and if this kind of work is allowed to continue, the gardens in a few years time may be without any water in the dry season.

The Boston Fruit Co. have given up about ten acres of the wood land that was leased to them.

The garden line has been opened by the Surveyor General's Department. Trees have been planted to mark the points. The trees used are Spathodea campanulata, and Dracaena draco.

About 50,000 Sweet Orange seeds have been sown.

Many Mango and Imperial Lemon plants have been raised by inarching.

The large Climber of Norantea guianensis has had to be cut back as it was killing several other large trees. Two more young plants of the same species have been planted out in suitable places with large trees to run upon.

Several climbers have been planted to run on suitable trees.

The roots of the bamboo that were cut down on the economic side of the Garden have been dug out, and several economic trees planted out on the ground.

The Liberian Coffee has borne well. The Coffea stenophylla flowered in March.

About 100 plants of the Coffee arabica have been planted out in order to compare the growth with the other species.

The Mangosteen fruited again, but I am sorry to say some of the fruit was stolen.

The Durian is making good growth. Two more Durian Plants have been received and planted out.

Two more plants of the Coco-de-Mer have been planted on the economic side of the road, those planted last year are making good growth.

The new land opened near the banana walk has been terraced on the lower side to prevent the heavy rains from washing away the soil.

The banana and cocoa land has been thoroughly forked and the different kinds of economic plants are looking all the better for it.

The small old trees of Bertholletia excelsa, that had been planted about the banana walk, have made wonderful growth since the land about them was trenched and manured, some have made three feet of growth.

This has been the driest Spring on record for Castleton; we would have had to carry water from the river if the drought had continued another week, although we have good tanks.

The mango trees have fruited on account of the unusual drought.

The sloping land on the North West part of the Garden has been cleared of the bush, fenced and planted with a good collection of timber and flowering trees. Four acres of bush land have been cleaned for grass and planting trees at some future time.

64 lots of seeds have been collected for distribution.

A large bell has been bought for the Gardens.

Visitors to the Gardens are on the increase.

The office and Coolie barracks have been reshingled and painted by the Public Works.

530 letters have been received and 1,192 despatched.

Plants Distributed.

" *Plants sold* :—		
Ornamental plants	...	1,410
Economic "	...	4,192
" *Plants sent to Hope Gardens* :—		
Ornamental plants	...	3,259
Economic "	...	5,196
" Total number of plants sold	...	5,602
" " sent to Hope	...	8,455
" " sent out	...	14,057

List of Plants planted out at Castleton Gardens, 1897-98.

Albizzia odoratissima, Benth. E. Indies.
Antidesma Bunius, Spreng. E. Indies, Malay.
Aristolochia indica, Linn. E. Indies.
Aristolochia Tagala, Cham. Luzon.
Barklya syringifolia, F. Muell, Australia.
Bassia butyracea, Roxb. E. Indies.
Bauhinia Hookeri, F. Muell. Australia.
B. picta, DC. N. Granada.
Bougainvillaea spectabilis, Willd. Brazil.
B. " var. speciosa
Brunfelsia jamaicensis, Griseb. W. Indies.
Caesalpinia pulcherrima, Sw. Tropical regions.
Camoënsia maxima, Welw. ex Benth. Tropical Africa.
Canarium commune, Linn. Moluccas.
Cassia Fistula, Linn. Tropical Asia.
C. glauca, Lam. Tropical Asia, Australia, Polynesia.
C. grandis, Linn. Panama.
C. pistaciæfolia, H. B. & K. N. Granada.
C. siamea, Lam. E. Indies Malaya.
Catalpa longissima, Sims. W. Indies.
Chamaerops humilis, Linn. Western Mediterranean.
Cinnamomum Camphora, Nees & Eberm. China. Japan.

Cocos nucifera, Linn. Tropical regions.
Cocos Yatay, Mart. Argentine.
Colvillea racemosa, Boj. Madagascar.
Corypha umbraculifera, Linn. Tropical Africa E. Indies.
Dæmonorops propinquus (from Kew, Aug. 1897.)
Datura cornigera, Hook. Mexico.
Dioon sp. Mexico
Dracæna Godseffiana, Hort., W. Trop. Africa.
Durio zibethinus, Murr. Malaya.
Erythrina umbrosa, H. B. & K. South America.
Ficus Benjamina, Linn. Trop. Asia.
F. lucida, Ait. Hort. Kew. E Indies.
F stipulata, Thunb. China & Japan.
Fugosia flaviflora, F. Muell. Australia
Geonoma Swartzii, Griseb. Jamaica and Cuba.
Grevillea robusta, A. Cunn. Australia.
Hæmanthus multiflorus, Martyn, South Africa.
Hæmatoxylon Campeachianum, Linn (Honduras.)
Hyophorbe amaricaulis, Mart. Mauritius.
Jacaranda filicifolia, D. Don. Panama.
Juniperus virginiana, Linn., N. America. Jamaica.
Kicksia africana, Benth. Tropical Africa.
Lagerstrœmia Flos-reginæ, Retz. Tropical Asia.
Landolphia sp. Africa.
Latania Loddigesii, Mart. Mauritius
Licuala grandis, H. Wendl. N. Britain.
Livistona australis, Mart. Australia.
L. Jenkinsiana, Griff. Himalaya.
Macaranga sp.
Monodora tenuifolia, Benth. Tropical Africa.
Mouriria guianensis, Poir. Guiana.
Oreodoxa regia, H. B. & K. Cuba. Panama.
Pandanus utilis, Bory. Madagascar.
Pentadesma butyracea, Sabine. Tropical Africa.
Phœnix dactylifera, Linn. Africa, Arabia.
P. pusilla, Gaertn. E. Indies.
P. tomentosa.
Pithecolobium pruinosum, Benth. Australia.
Poinciana regia, Boj. Madagascar.
Polyalthia suberosa, Benth & Hook. E. Indies, Burma.
Pritchardia pacifica, Seem & H. Wendl. Fiji.
Raphia vinifera, Beauv. Tropical Africa.
Sabal havenensis (from Vilmorin-Andrieux.)
Schotia latifolia, Jacq. South Africa.
Spathelia simplex, Linn. Jamaica
Spathiphyllum commutatum, Schott. Philippines.
Spathodea campanulata, Beauv. Tropical Africa.
Sterculia acerifolia, A. Cunn. Australia.
Stevensonia grandifolia, J. Duncan. Madagascar.
Strelitzia Augusta, Thunb. South Africa.
Strophanthus hispidus, DC. South Africa.
Taxodium distichum, Rich. N. America.

Tecoma serratifolia, G. Don. W. Indies.
Thrinax argentea, Lodd. Jamaica, Cuba, Haiti, Bahamas.
T. barbadensis, Lodd. Barbados.
Vanilla africana, Lindl. Tropical Africa.
Verschaffeltia splendida, H. Wendl Seychelles.
Wallichia sp.

The elevation of this Garden was supposed to be 580 feet above sea-level, but this appears now to be incorrect.

"After the readings have been reduced to the standards of Kew (—.005), gravity (—.063) and 32°, and compared with the Kingston readings, the height of Castleton appears to be 496 feet above sea-level there being used the following approximate formula :

$$\text{Height} = 48{,}727 + 58.3\ (T_1 + T_2)\ \frac{B_1 - B_2}{B_1 + B_2}$$

where T= temperature, and B= reading of barometer." (Weather Report for January, 1898.)

The average annual mean temperature is 76.1° F., and the average annual rainfall 113.29 inches for twenty-six years. The amount of rain that fell during the year was 116.77 inches.

The wettest months were April, May, September, October, and the driest were June, January, February and March.

The mean temperature for the year was 75.0° F.

The Meteorologial tables for the different months are given on page 317.

Hill Gardens.

The following Report is by the Superintendent, Mr Wm. Harris :—

The usual work of manuring, forking beds and borders, pruning, cutting lawn grass, sowing seeds, propagating, potting and watering plants, was attended to during the year, and the gardens and surroundings were kept constantly in excellent order.

In the maintenance of a good garden there are numerous matters of detail requiring unremitting care, which would be tedious to enumerate fully in an annual report. The beds in the old nursery garden have been renovated and planted with the better kinds of Geraniums, Fuchsia, etc. These are intended to form stock plants to supply material for propagating purposes.

A portion of the lawn, in the garden proper, suddenly sunk considerably below the proper level, thus forming a basin which was filled with water during rainy weather. It became necessary to lift the turf, level the ground, and re-lay the grass. This was done most successfully.

Orange Garden at Resource.

The work of getting this garden into a good state of cultivation has received special attention, and, so far, the results have been satisfactory. Weeds grow so rapidly that continual hoeing is necessary and, as they are not allowed to seed to any extent, they will, in time, be got under.

Nearly all the plants have had a dressing of good rotten manure, carefully forked in, and the surface then covered with litter to prevent excessive evaporation. This treatment has had a most beneficial

effect on the growth of the plants, and can be recommended for oranges planted in similar comparatively dry situations.

Leguminous plants, such as Cow Pea, Hairy Vetch, and Congo Pea have been largely grown through the plantation. These not only shade the ground, and, to a certain extend retard, or altogether prevent the growth of weeds, but they also increase the supply of nitrogen in the soil.

Nitrogen is an important part of the food of plants, and as matters containing it exist only sparingly in most soils, and as they are easily exhausted, it becomes necessary to adopt other means of keeping up the supply of this aliment. Mr. H. J. Webber of the U.S. Department of Agriculture speaking of nitrogen as a fertiliser for oranges says: "A grower may with considerable certainty determine by the appearance of his trees the condition of his grove in respect to the supply of nitrogen available in the soil. An abundance of nitrogen is indicated by a dark green colour of the foliage, and rank growth . . . . . If the trees have a yellowish foliage, with comparatively small leaves, and show little or no growth, there is probably a lack of nitrogen . . . . . If the tree is starving from a lack of nitrogen, the foliage will become very light yellow, and sparse, and the small limbs will die, as will also the large limbs in extreme cases. If the starvation is continued, no fertiliser being added, the tree will finally die back nearly to the ground, and probably die out entirely."

Fertilisers are expensive, and require to be applied with considerable judgment and care, the use of green manuring, therefore, is advocated as being a more economical and less risky method of supplying the desired elements.

Citrus.—The following is a list of the Citrus plants now under cultivation at Resource:—

Orange—	Dom Louise,	Messrs Rivers,	England.
"	Bitten Court	"	"
"	St. Michaels	"	"
"	Botelha	"	"
"	Egg	"	"
"	Jaffa	"	"
"	Maltese Blood	"	"
"	Silver, or Plata	"	"
"	Jaffa Blood	"	"
"	Pernambuco	"	"
"	Embiguo, or Navel	"	"
"	Sustain	"	"
"	Oval	"	"
"	White	"	"
"	Seville	"	"
"	Tangierine	"	"
"	Centennial,	Messrs. Reasoner Bros.,	Florida.
"	Whitaker	"	"
"	Tardif	"	"
"	Dancy's Tangierine	"	"
"	Parson Brown	"	"
"	China Mandarin	"	"
"	Satsuma Mandarin	"	"

Orange—Ruby Blood,	Messrs.	Reasoner Bros.,	Florida
" Majorca	"	"	
" Homasassa	"	"	
" King	"	"	
" Boone's Early	"	"	
" Beech's No. 1	"	"	
" Otaheite	"	"	

Pomelo, or Grape Fruit, Royal, Messrs.	Reasoner Bros.,	Florida.
" " " Pernambuco	"	"
" " " Aurantium	"	"
" " " Tresca Blood	"	"

Lemon. Sweet Brazilian. From	Messrs.	Rivers,	England.
" Imperial	"	"	"
" Sweet	"	"	"
" Common	"	"	"

" Blair Premium. From	Messrs.	Reasoner Bros.,	Florida.
" Villafranca	"	"	"
" Genoa	"	"	"
" Rough (Wild)			

Shaddock. From	Messrs.	Rivers,	England.
Forbidden Fruit	"	"	"

Citrus corniculata. From Messrs.	Reasoner Bros.,	Florida.
Kumquat, round	"	"
" oval	"	"
Citron	"	"

Also a large number of plants received from California and Florida the names of which were lost in transit. In addition to above, we have the ordinary Jamaica orange, the very best variety of Jamaica Grape Fruit and Navel orange from buds obtained in Jamaica from Hon. J. T. Palache and Hon. Col. Ward; also ordinary Shaddock, (3 kinds) and Lime (Sweet and Common).

Timber Trees.—We have at the present time a large number of seedling West Indian Cedar, and young plants of Juniper Cedar which will be distributed when large enough to send out. Many of the Juniper Cedars are large enough now, but they have just been transplanted. West Indian Cedars, and Pinus sinensis have now been planted at regular intervals along all our line, and dividing fences. These will form permanent growing posts in time.

Widdringtonia Whytei, the Mount Mlanje Cypress. We have successfully raised a large number of plants of this valuable African timber tree, and they look healthy and promising.

Blue Mountain Coffee.—A large quantity of seed of the best Blue Mountain Coffee was sown during the year, and an extensive nursery of young plants is being formed to supply planters who experience difficulty in obtaining supplies of young plants when required.

Cassava.—An experimental plot of Cassava, both bitter and sweet, has been established, and the plants are growing luxuriantly.

Budding Oranges etc.,—It is still a question which months, or seasons of the year are the best to perform this operation. As far as our

experience goes, plants budded during July and August gave decidedly the best results, whilst those budded in January were a complete failure.

It ought to be mentioned, however, that the latter plants looked very promising for about a fortnight, during which period the weather was cool, but dry, then showery weather set in with the result that not a single bud survived. Now that stock plants and buds are available, experiments in budding will be carried out every month, and the results carefully noted, and it is hoped that we shall then be able to arrive at some definite conclusions as to the best time, or times of the year to carry on this work.

Fruit Trees.—The European fruit trees are thriving remarkably well and two of the imported young Apple trees bore good crops of fruit. The following also fruited :—Mulberry, Fig, Peaches, Strawberries, and a small tree of Ruby Blood Orange. Strawberries grew very freely, but the varieties of these and of Peaches under cultivation are not of the best.

Fodder Plants. In last Annual Report mention was made of Teosinte. I am now enabled to supply some further information about this valuable fodder plant.

Teosinte (*Euchlaena Mexicana,*) Schrad, is a native of north and south Mexico, the mountains of San Miguelito, San Luis Potosi, San Augustin near the Pacific, and Guatemala. It is an annual but readily reproduces itself on good land from seed shed.

Seed was sown at Resource in April, at an elevation of 3,600 feet. The soil, which is a gritty loam with a good deal of clay intermixed, resting on a sub-soil of red clay, was turned up to a depth of one foot, and, after exposure to the sun and air for a few days, was thoroughly broken up. The seed was then planted in much the same way as Maize or "great corn" is planted, *i.e.* shallow holes were made about 20 inches apart with a "digger," and 2 or 3 seeds dropped into each hole, and covered with surface soil. The seeds soon germinated and the young plants grew quickly. The ground between the plants was hoed twice. Vegetation was so rapid that the foliage of the plants soon covered the ground, and prevented the growth of weeds.

Teosinte began to flower on the 10th October about six months from the date of planting the seeds. On the 23rd October as the plants were in full flower, with several immature spikes of seed to each stem they were thought to be in good condition for feeding purposes, and half the crop was cut down to test the yield, and its value as green fodder.

Fifteen to eighteen stems were produced from each root, and they had attained a height of 8 to 10 feet. They were cut at six inches above the ground, tied in bundles and carefully weighed, when the yield was found to be at the rate of 44,000 lbs. or over 19½ tons per acre. The stems were then given to horses and mules and were readily eaten. One or two of the horses ate everything but the others rejected the hard lower portions of the stems, or about one-eighth of the total weight given them.

The rainfall during the time the plants were growing amounted to 28.83 inches distributed as follows :—

April	...	...	2.03
May	...	...	6.30
June	...	...	1.00
July	...	...	2.43
August	...	...	4.10
September	...	...	5.72
October to 23rd	...	...	7.25
			28.83 inches.

with a larger rainfall, it is possible that the yield, heavy as it was, would have been much heavier.

The plants are said to ratoon freely, but ours did so but sparingly. The stems were probably cut too close to the ground, if 1 to 2 feet of each stem had been left they might have ratooned more freely.

For fuller information, and an analysis of the seed, see Bulletin for February, 1896. This plant ought to be suited for growing in sheltered valleys along the coast from St. Margaret's Bay to Manchioneal where Guinea grass has failed to establish itself.

Himalayan Grass (Pennisetum orientale, Rich.).—This splendid grass contiuues to grow luxuriantly and, as it produces seed freely, it will, no doubt, spread in the course of time.

Bermuda Lilies.—This experiment has not proved a success.

There is no resting period during which the bulbs may be lifted and shipped ; before the old growths are ripened new shoots are formed and grow vigorously. In a drier district it may be possible to grow this lily successfully.

Plants Distributed.

Economic Plants :—

Sweet Oranges	...	...	21,850
Sour do.	...	...	11,000
Grape Fruit-seedlings	...	...	3,240
Do. budded	...	...	300
Shaddock	...	...	775
Tangierine Oranges	...	...	506
Limes	...	...	200
Budded Navel Oranges and Citron		...	6
Blue Mountain Coffee	...	...	14,750

Free Grants.

West Indian Cedar	...	...	11,560
Ramie	...	...	1,000
Other Economic plants	...	...	909
Ornamental—various	...	...	603
Total Economic plants distributed		...	66,096
Ornamental " "		...	603
Total number of plants distributed		...	66,699

The following seeds were also distributed :—

15 quarts of Tea seed
1 lb. Cinchona "
1 lb Tree Tomato "
and of Tree Tomato fruits, 76 lbs. or 38 dozens.

The *elevation* of the Hill Garden House, where the instruments are placed, is 4,907 feet above sea-level.

The average mean temperature there is 62.6° F., and the average annual rainfall 102.2 inches for 27 years.

The amount of rain that fell during the year was 96.08 inches June, July and January were the driest months, and September, October and November the wettest. The mean temperature was 62.9° The Meteorological tables for the different months are given on pages 315, 316.

The rainfall at the Orange Garden, Resource, was 53.70 inches for the year. The driest months were June, July, and January, and the wettest months—May, October and November.

KINGS HOUSE GARDEN AND GROUNDS.

The following Report is by Mr. W. Walker, Superintendent :—

Having only assumed charge in November last I can simply state that I found the grounds and garden in excellent condition. The lawns, paths and borders showing that care and attention have been bestowed on them. All was clean and in good order and the plants in the nursery and at the house were in a healthy and flourishing condition.

At the request of His Excellency Sir A. Blake, the long grass was cut on the pleasure ground southwest of the vinery, and all along inside the borders each side of the avenues, the road itself has been cleaned frequently, the bord rs from east to west have been dug up and kept well watered but I should recommend they have a thorough overhauling and renovating, the larger growing plants removed from the front and vice versa, keeping in view the proper blending of the different colours.

A kitchen garden has been established but is very limited in size. The produce is very satisfactory, giving some very fine Tomatoes, Cabbages, Carrots, Turnips. Beet, Lettuce, Beans, etc.

The large vinery was pruned and well cut back in February, and has broken well and shows for a very good crop. The smaller one was attended to 6 weeks later and is now showing well for a good crop. 1 should recommend the extension of the larger one and the planting of some young vines.

The Victoria Regia in the large tank, which was planted in January, 1897, is not doing at all well, the leaves never fully develop but get black and rot off. I attribute it to the cold nights we have had. A plant or two put in in April might prove more satisfactory.

The Rosaries have been well manured and dug up, but with the exception of one small bed, they are old and worn out, and I should recommend that a new Rosary be established as soon as possible.

The elevation of the garden above sea-level is 400 feet.

The average mean annual temperature is 78°4 F., and the average annual raintall 48.20 inches for eighteen years. The amount of rain that fell during the year was 64.66 inches.

The wettest months were May, August, September, October, and the driest were June, December, and March.

The mean temperature for the year was 77.2° F. The Meteorological tables for the different months are given on page 318.

Kingston Public Garden.

The following Report is by Mr. J. Campbell, Superintendent:—

During the year under review the garden operations have beeen carried on to the greatest extent that its allotment would allow. The beds and borders have been heavily manured twice, and on both occasions deeply forked, been frequently weeded, the necessary pruning done, plants trimmed, trees divested of dried branches, verges and edges cut and trimmed, watering, sweeping, cleaning up, and carting away of rubbish, daily attended to.

The garden suffered from a continuous drought for a lengthened time which necessitated continued watering daily, and sometimes at night until the autumnal rains which lasted sometime this year: some of the large trees had commenced to fade, but by the incessant rains they were all invigorated.

Plants of Oreodoxa regia have been planted out, and are growing; they will make a fine appearance when developed, as they are planted at the angles, and sides of pathways.

The Euphorbia which was planted along the side of the aqueduct, mentioned in a former report, has developed into a fine hedge, and is an improvement.

The lawns which had become quite bare of grass, from the trampling of the people, I am glad to report, have been since enclosed with an iron fence, with gates opening to each enclosure Grass has been planted throughout the plots, which has grown, and covered the area, giving a pleasing appearance. After the erection of the fence, some evil disposed persons have from time to time maliciously destroyed the wires, and in some parts drawn them out. I have now turned the top and bottom ends of the wires, which makes it impossible for anyone to take them out. I have repaired the fence throughout. The Police authorities have been informed; they now send Constables in plain clothes to detect the depredators. Having discovered that they had again commenced to damage the wires by inserting a stick, and twisting them out, I instructed the Constable in charge to keep a watch near by the following night, when a man was discovered maliciously damaging the fence. He was brought up at the Police Court, and fined heavily.

The manure pit enclosure has been repaired, and painted, which is an improvement to that part of the garden. The bridges require repairing and the walks gravelling.

The tanks have been cleaned out, and fresh mould put in the mounds for replanting aquatic plants.

The infringements on the Garden Regulations have been dealt with at the Police Court.

The elevation of the Garden above sea-level is 60 feet.

The average mean annual temperature is 79° F., and the average annual rainfall 35.16 inches for twenty-eight years. The amount of rain that fell during the year was 46.78 inches. The wettest months

were May, September, October, and the driest were November, December and January.

The mean temperature for the year was 79.4° F. The Meteorological tables for the different months are given on page 318.

BATH GARDEN.

The following report is by Mr. A. H. Groves, Overseer of the Garden :—

The unusually dry weather that prevailed during the earlier part of last year had its effects. The Garden, however, did not suffer seriously. This is undoubtedly owing the free use of water from the well throughout the Garden, and the seasoning showers of rain from April last year to the earlier part of February this year.

As the dry weather set in about this time and extended to the end of March, watering apart from the usual supply to the plants, has had to be resorted to, so as to keep the plants fresh and green.

With the exception of a few patches here and there, the garden had been forked throughout. This work has been tedious, owing to the roots of the trees in the ground, and therefore a much larger amount has been spent in comparison with a piece of land of the same area freed of roots, etc.

However, this work has benefited the Garden to a very great extent, and I feel confident in saying that the present state of the Garden is due in some measure to it.

The usual work has been performed. I had felled a large Spathodea which was decaying, as I feared it would do serious damage to the fence and plants if allowed to fall. The felling was done by first removing the branches, and cutting off pieces of the trunk to avoid injury to the fence, plants, etc.

The benches have been repainted. Owing to the dampness of the climate here, paint mildews quickly.

I think a small pump and a sufficient quantity of hose, as recommended in my last Report, would suit the Garden admirably.

I shall again call on the Parochial Board to deepen the trenches along the south and west of the Garden. At present it cannot well relieve itself of the water during rainy seasons, the trenches outside the Garden not being deep enough ; those in it are shallow, and get filled up with dirt, thus causing the water to flow back into the Garden.

The standards, droppers and gate have been painted. The fence around the Garden is in fair order.

I have to thank the many persons in and around Bath for rose plants received from them, particularly Mrs. A. C. Neyland who has given me several cuttings from her choice Roses.

W. FAWCETT,
Director.

APPENDIX.

Hill Gardens. Elevation, 4,907 Feet

Month	*Pressure.		Temperature, Degrees Fahrenheit.					Dew Point.		Humidity.		Wind.		Rainfall, Inches.
	7 a.m.	3 p.m.	7 a.m.	3 p.m.	Max.	Min.	Range.	7 a.m.	3 p.m.	7 a.m.	3 p.m.	Direction.	Force, Miles.	
1897.	In.	In.	°	°	°	°	°	°	°					
April ...	25.222	25.194	60.6	64.7	68.9	55.2	13.7	54.2	60.1	77	83	E	12.0	6.87
May ..	.297	.169	62.9	64.9	68.6	58.8	9.8	57.9	62.7	83	93	E	10.9	9.30
June ...	.256	.225	63.5	67.6	71.0	59.0	12.0	58.8	62.2	83	81	E	18.6	0.91
July ...	.255	.196	63.0	67.4	71.5	59.3	12.2	57.8	62.1	83	84	E	17.9	2.02
August ...	.260	.233	63.7	68.4	72.5	60 0	12.5	58.6	63.0	83	81	E	55.4	5.38
September ...	.219	.190	62.9	66.5	70.0	59.5	10.5	58.9	63.6	86	89	E	19.3	11.32
October .	.188	.153	61.9	64.5	68.4	58.2	10.2	58.9	61 6	87	90	SE	38.8	32.93
November ..	.218	.180	60.5	65.8	69.8	57 3	12.5	56.3	61.5	83	85	E	30.8	11.09
December ...	.232	.190	59.4	64.4	68.5	55.8	12 7	54.9	59.8	82	84	E	50.9	6.63
1898.														
January ...	.251	.219	57.1	64.1	67 4	53.1	14.3	51.7	58.8	80	82	E	46.9	3.04
February ...	.279	.245	55 9	61.6	64.9	52.8	12.1	51.9	57.6	85	85	E	18.9	4.51
March ...	.203	.171	55.7	63.4	67.1	52.8	14.3	51.4	57.4	85	80	E	61.4	2.08
Means ..	25.240	25.197	60.6	65.2	69.0	56.8	12.2	55.9	60.8	83	84	E	31.8	96.08
					Mean 62.9									

* The Barometer pressures are reduced to the Standards at Kew, 32°, and gravity at Lat. 45°.

Month.	Hill Garden Resource—Elevation 3,700 feet.	Blue Mountain Peak—Elevation 7,423 feet.					
	Rainfall, Inches.	Date of Observation.	Time of Observation.	Temperature.	Max.	Min.	Rainfall, Inches.
1897.				°	°	°	
April	5.50	30.4.97	10 a.m.	60	70.9	42.8	10.08
May	6.40	31.5.97	12.30 p.m.	64	66.9	42.8	11.10
June	0.34	30.6 97	10 a.m.	65	70.9	44.8	6.03
July	0.14	31.7.97	9.15 a.m.	54	69.9	41.8	5.15
August	3.09	31.8.97	12.30 p.m.	51	68.9	44.8	8.50
September	5.36	3[illegible].9.97	12.10 p.m.	53	66.9	40.8	14.10
October	20.42	31.10.97	11.45 a.m.	66	68.9	43.8	24.20
November	6.80	30.11.97	12.15 p.m.	65	68.9	40.8	24.55
December	2.00	31.12.97	11.45 a.m.	65	66.9	41.8	18.35
1898.							
January	0 00	1.2.98	7.35 a.m.	50	66.9	37.8	7.25
February	3.50	1.3.98	11.10 a.m.	58	64.9	48.8	5.55
March	0.15	1.4.98	11 a.m.	60	67.9	50.8	5.42
Means	53.70			59.2	68.2	43.3	140.28
	Total				Mean 55.7		Total

Hope Gardens.- Elevation, 700 Feet.

Month.	Pressure.		Temperature. Degrees Fahrenheit.					Dew Point.		Humidity.		Rainfall—Inches.
	7 a.m.	3 p.m.	7 a.m.	3 p.m.	Max.	Min.	Range.	7 a.m.	3 p.m.	7 a.m.	3 p.m.	
1897.	In.	In.	°	°	°	°	°	°	°			
April ...	29.24	29.24	72.0	83.6	88.3	67.8	20.5	66.7	69.9	84	63	2.12
May ...	.20	.21	73.4	83.7	87.3	68.6	18.7	70.4	69.3	87	60	7.56
June ...	.26	.27	74.3	86.7	89.9	69.5	20.4	69.9	71.6	87	61	1.10
July ...	.26	.27	73.7	84.3	89.3	69.6	19.7	68 3	72.5	79	66	2.89
August ...	.27	.28	73.4	86.4	90.3	70.3	20.0	72.0	71.5	90	63	4.82
September	.24	.23	73.2	82.8	87.9	69.8	18.1	69.5	74.1	90	74	10.43
October ...	.18	.19	71.5	80.2	83.9	68 4	15.5	69.7	74.4	93	82	24.60
November	.21	.22	71.1	82.1	87 9	67.2	20.7	66.7	73 7	87	76	3.82
December	.24	.25	68.3	84.3	88.8	65.3	23.5	66.3	75.5	87	65	0.75
1898.												
January ...	.27	28	65.6	82.3	87.7	63.2	24.5	62.1	69.7	90	67	0.92
February...	.24	.25	65.1	80.3	86.8	61.4	25.4	60.7	69.5	87	71	2.72
March ...	.22	.25	67.1	82.6	86.0	62.3	23.7	61.7	67.0	84	58	0.66
Means ...	29.23	29.24	70.7	83.2	$\underbrace{87.8 \quad 66.9}_{\text{Mean } 77.3}$		20.9	67.0	71.5	87	67	62.39 Total.

Castleton Gardens—Elevation, 496 Feet.

Month.	Pressure.*		Temperature. Degrees Fahrenheit.					Dew Point.		Humidity.		Rainfall—Inches.
	7 a.m.	3 p.m.	7 a.m.	3 p.m.	Max.	Min.	Range.	7 a.m.	3 p.m.	7 a.m.	3 p.m.	
1897.	In.	In.	°	°	°	°	°	°	°			
April ...	29.99	29.90	69.8	80.6	85.9	62.8	23.1	68.3	72.0	93	74	13.42
May ...	.90	.86	72.6	81.9	86.4	64.6	21.8	70.1	78.2	90	88	17.06
June ...	.93	.88	73.0	84.5	89.1	64.7	24 4	69.8	71.4	90	62	4.31
July ..	.94	.91	73.0	83.1	86.6	67.8	18.8	69.6	75.5	85	77	5.95
August ...	96	.91	72.0	83.4	87.4	67.5	19.9	69.8	77.3	90	79	9.09
September	.93	.87	70.9	81.0	86.7	67.3	19.4	68.2	74.7	88	82	17.15
October ...	.88	.82	71.7	79.0	84.6	68.1	16.5	68.8	72.9	90	78	20.88
November	.92	.86	70.7	80.2	84.3	66.3	18.0	68.0	72.4	90	76	12.68
December	.97	.90	69.1	80.3	83.5	64.4	19.1	67.2	72.1	85	71	7.75
1898.												
January	.99	.92	65.7	78.2	84.8	60.4	24.4	64.8	70.0	88	72	4.67
February	.99	.92	64.8	77.2	81.8	60.6	21.2	60.9	69.7	86	74	1.44
March	.97	.90	66.6	79.6	82.4	63.6	18.8	64.2	70.0	89	70	2.37
Means	29.94	29 88	69.9	80.7	$\underbrace{85.3 \quad 64.8}_{\text{Mean } 75^\circ.0}$		20.5	67.4	73.0	88	75	116.77 Total.

* The Barometer pressures are reduced to the Standards of Kew, 32°, gravity at Lat. 45°, and mean sea-level.

King's House Gardens.—Elevation, 400 Feet.

Month.	Temperature. Degrees Fahrenheit. 7 a.m.	3 p.m.	Max.	Min.	Range.	Dew Point. 7 a.m.	3 p.m.	Humidtiy. 7 a.m.	3. p.m.	Rainfall—Inches.
1897.	°	°	°	°	°	°	°			
April ...	71.6	85.9	90.5	65.0	25.5	67.9	72.5	87	65	1.85
May ...	74.3	83.6	89.8	67.1	22.7	70.4	69.3	87	60	5.75
June ...	74.5	88.1	92.5	67.6	24.9	70.8	75.8	87	67	0.54
July ...	73.7	86.8	91.2	66.8	25.4	70.7	77.9	96	74	2.08
August ...	74.3	88.7	92.7	68.3	24.4	71.3	79.7	90	74	5.95
September ...	73.4	84.2	89.6	67.3	22.3	70.7	77.7	93	82	10.40
October ...	73.1	81.4	86.7	66.3	20.4	71.0	75.6	93	84	28.75
November ...	72.1	82.6	89.4	65.1	24.3	68.7	75.7	90	79	2.75
December ...	69.3	83.5	89.1	62.5	26.6	65.5	73.3	90	70	0.34
1898.										
January ...	66.4	82.6	88.4	60.7	27.7	62.7	72.2	90	69	1.45
February ...	65.2	80.9	85.9	60.8	25.1	62.2	75.1	87	82	4.00
March ...	67.3	85.6	88.2	63.2	25.0	64.5	73.3	91	65	0.80
Means ...	71.2	84.5	89.5	65.0	24.5	68.0	74.8	90	72	64.66
			Mean 77°2.							Total.

Kingston Public Garden.—Elevation 50 Feet.

Month.	Pressure. 7 a.m.	3 p.m.	Temperature. Degrees Fahrenheit. 7 a.m.	3 p.m.	Max.	Min.	Range.	Dew Point. 7 a.m.	3 p.m.	Humidity. 7 a.m.	3 p.m.	Wind. Direction.	Force—Miles.	Rainfall—Inches.
1897.	In.	In.	°	°	°	°	°	°	°					
April .	29.935	29.922	74.6	84.0	86.9	72.1	14.8	67.3	70.0	78	63	SSE	94.0	2.00
May .	29.881	29.888	78.1	85.1	87.9	73.6	14 3	70.7	73.8	78	66	SSE	84.7	3.47
June .	29.942	29.934	79.3	86.5	89.1	74.5	14.6	70.0	71.4	73	61	SSE	119.0	0.58
July .	29.957	29.945	77.5	86.2	89 1	73.5	15.6	69.4	72.5	77	65	SSE	94.6	1.74
August .	29.995	29.935	76 3	86.8	89.5	74.0	15.5	70.4	72.9	83	64	SE	89.5	2.13
September	29.927	29.873	76.4	85.1	88.8	73.9	14.8	71.1	73.2	84	68	SE	74.7	8.84
October .	29.887	29 826	74.2	82.2	85.4	72.2	13.2	71.4	73.1	91	76	SE	32.8	23.45
November	29 931	29.862	72.7	83.9	88.3	71.3	17.0	68.5	71.0	87	66	N	34.5	0.48
December	29.965	29.893	71.1	85.0	88.6	69.7	18.9	65.7	68.5	83	58	N	41.1	0.09
1898.														
January .	30.001	29.926	69.2	84.1	86.8	68.1	18.7	62.7	66.6	80	57	SE	56.8	0.03
February	29.970	29.907	68.2	82.2	84.8	66.4	18.4	62.2	67.1	81	61	SE	36.3	2.66
March .	29.962	29.892	69.7	83.7	85.7	67.4	18.3	63.5	66.0	81	56	SE	41.7	1.31
Means .	29.946	29.900	73.9	84.5	87.5	71.3	16.2	67.7	70.5	81	63	SE	66.6	46 78 Total.
					M. 79.4									